PUBLIC WORKS

CITY COUNTY STATE

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CITY COUNTY STATE

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Vol. 57 May, 1926 No. 4

Maintaining Dirt Roads

More than two and a half million miles of third class roads, mostly dirt and gravel, present a maintenance problem of the greatest importance. Some figures relative to maintenance work done by counties—equipment used, frequency and results obtained.

There are nearly three million miles of roads in the country which have not been given a hard or durable surface and which can not be expected to receive such surface for many years to come if ever, since the cost would be beyond all reasonable anticipation of what will be available, and since a large part of the mileage does not carry enough traffic to warrant such expense. However, these roads carry some traffic, and it is desirable that they be at least reasonably passable throughout the year and that they have as firm and smooth a surface as possible during the greater part of the year.

Some kinds of natural soil or dirt roads can be kept in this condition with comparatively small expenditure for either construction or maintenance. There are, however, certain localities where it is necessary to provide as complete artificial drainage as the traffic to be carried will justify, following which a good surface may be maintained with a reasonable amount of intelligent maintenance. In other localities or other soils, the drainage problem may not present itself, but difficulties of maintenance may necessitate more frequent or expensive maintenance methods; among which would be included those localities where rainfall is very infrequent and methods must be employed for maintaining a good surface with dry material.

A clay or clayey loam road, when the surface is smooth and firm, is as good a road for ordinary light traffic as could be asked for and is more comfortable to ride on than many good hard-surface roads. How to keep it in such condition is a problem that should receive much more attention than it does. The procedure must involve comparatively little expense and only moderate-price equipment.

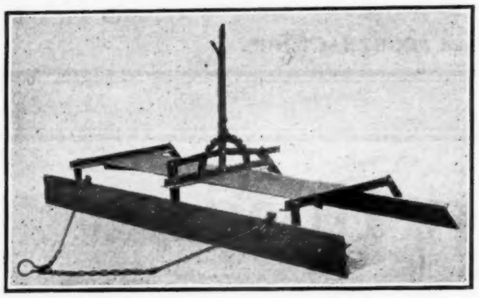
Among the tables published in this issue will be found one showing the amount spent by each of several hundred counties in maintaining roads of different kinds. Because of the importance of the dirt or natural soil roads, special questions were included in this year's questionnaire dealing with this class of road only, and one of the tables gives the information obtained in reply to these questions. This included the kind of soil, the width and crown of the graded sections, the miles of road kept in condition by the use of drags, graders, etc. and the equipment used; also the frequency with which the equipment is used on a given stretch of road, together with any other maintenance treatment which the roads receive; and finally the county official's estimate as to the percentage of time during which the roads may be considered to have a firm, smooth surface. The following paragraphs give a summary of the information obtained, which is presented in detail in the tables referred to.

FREQUENCY OF TREATING A GIVEN ROAD

Information under this head might be divided into two classes, one in which the frequency was given as related to the weather, and the other as defined by periods of time. Under the first head, 29 counties reported that the maintenance gangs got to work immediately after each rain; one that the work was done after each wet spell; one after rains and freezes; 4 as the weather permitted; one during the spring and periodically after that, and one from 2 to 6 times after the spring rains.

The others indicated frequency by the time elapsing between treatments, number of treatments per month, etc. Of these, 9 reported treatment daily and 9 others reported continuous treatment. (It may be that some of these meant that the maintenance gang was continuously operating and not that each mile of road was passed over each day.) One reported 4 times a week; three, 3 or 4 times a week; eight, 3 times a week; thirty-five, twice a week; one, 100 times a year; four, once or twice a week; one, 65 times a year; one, 75 times a year; one, 5 times a month; nineteen, weekly; two, 45 times a year; two, 40 times a year; three, 3 times a month; six, once in two weeks; four, twice a month; one, once every 20 days; one, 12 times a

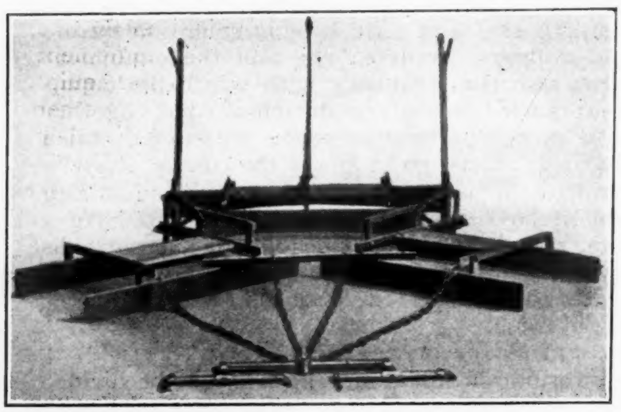
year; one, 8 to 15 times a year; eight, monthly; one, 10 times a year; one, 6 times a year; one, once in three months; two, 4 times a year; four,



A TWO-BLADE ROAD DRAG

3 times a year; two, 2 or 3 times a year; four, twice a year, and one, once every two years.

Four distinguished between state and county roads, one reporting that the maintenance for the state roads was continuous, while county roads were dragged after each rain; another, that state roads were treated daily and county



A THREE-WAY ROAD DRAG

roads weekly; a third, that the state roads were gone over once in 10 days and the county roads twice a year; and the fourth that the intervals were two weeks for the state roads and two months for the county roads.

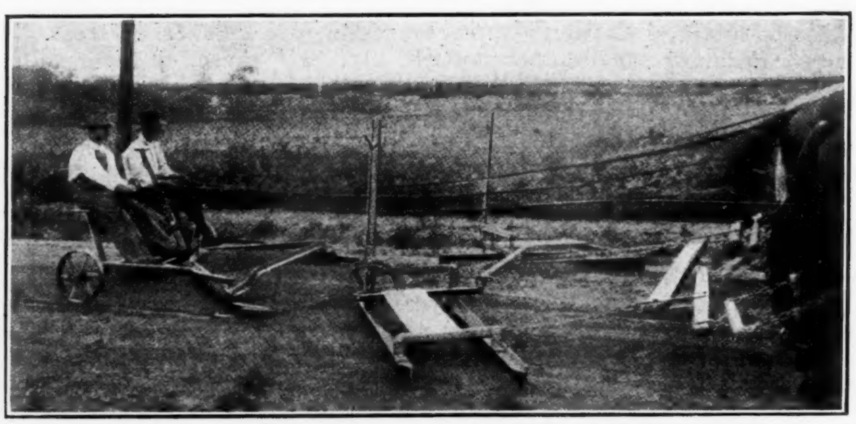
Replies to the inquiry as to what percentage of the time, on the average, the roads of a given county have a firm, smooth surface cannot perhaps be compared too exactly, both because the standards of comparison and the individual ideas as to what constitutes a firm, smooth surface probably vary in different parts of the country, and also because the personal interests of those reporting would naturally tend to bias some in favor of the roads which they are endeavoring to maintain in that condition. However, we believe that in the majority of cases the replies can be accepted as giving some idea of the percentage of time during which the roads are in fairly good condition.

Of the 152 counties which replied to this question (a great many apparently did not wish to commit themselves, or found it difficult to make an estimate), more considered that the roads of their counties offered a firm, smooth surface three-quarters of the time than any other one percentage, 36 so reporting. The next largest number, 26, reported the roads in this condition ninety percent of the time, while 17 considered them to be so fifty percent of the time. Grouping the replies more or less arbitrarily, we find the following: Six reported the roads in the condition described 100 per cent of the time; fifty-eight, from 76 to 99 per cent of the time; thirty-six, 75 percent of the time; twelve, 51 to 74 percent of the time; thirty-one, 26 to 50 percent of the time; and nine, 25 percent of the time or less. Ten reported that the roads were in good condition after each surfacing until the next rain; a number of these being located in sections where rain is very infrequent. One was frank enough to state that in his county the roads were never firm and smooth, two that they were in this condition only 10 percent of the time, and two others that this was true only 20 percent of the time.

MAINTENANCE EQUIPMENT EMPLOYED

More definite, and for this reason at least of more value and interest, were the statements as to the equipment employed in the different counties. One hundred and ninety-nine counties furnished a list of their equipment employed in maintaining the surface of dirt roads.

Drags appeared to be much the most numerous in use, several specifying steel drags and others wooden drags. Second in popularity were graders and patrol graders. Aside from the drags, much of the other equipment has a greater or less similarity, the variation indicated by different names occasionally being slight, and in some cases probably the same equipment goes by different names in different counties. In the list herewith, the names given are those under which the equipment was reported to us. Drags were reported used by 135 counties, graders by 95, and patrol graders by 42; maintainers were reported



ANOTHER MAKE OF THREE WAY DRAG

by 37 counties, scrapers by 23 counties, blades by 12 counties, planers by 4 counties, road machines by 4 counties, patrol blades by 2 counties, and one county reported each of the following: scarifiers, harrows, finishers, fixers, slips, mowers, levelers and rollers.

This equipment was employed in different combinations in the different counties, as shown in the accompanying table:

EQUIPMENT USED IN MAINTAINING DIRT ROADS

Equipment	Number of counties reporting
Drags	21
Drags and graders	43
Drags and patrol graders	18
Drags and scrapers	
Drags and planers	1
Drags and patrol blades	2
Drags and maintainers	12
Drags and road machines	2
Drags, patrol graders and finishers	1
Drags, graders and maintainers	11
Drags, graders and planers	2
Drags, graders and scarifiers	1
Drags, graders and harrows	1
Drags, patrol graders and finishers	1
Drags, blades and road fixers	1
Drags, blades and scrapers	1
Drags, graders, scrapers, maintainers	4
Drags, graders, slips and mowers	1
Drags, graders, scrapers and levelers	1
Graders	19
Patrol graders	19
Graders and maintainers	6
Graders and scrapers	1
Graders and planers	1
Graders and blades	2
Graders, blades and maintainers	1
Graders, scraper and rollers	1
Blades	6
Scrapers	2
Scrapers, patrols and blades	1
Maintainers	3
Road machines	2

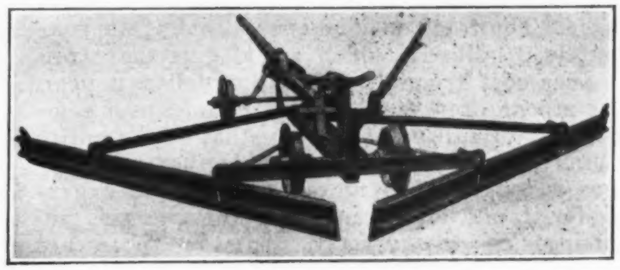
In comparing the different equipment used and also the frequency with which it was used and the results obtained, it will be interesting and valuable to consult the general table and note the kind of soil which was being treated and also the geographical location and climate, both of which generally have a very considerable weight in determining the kind of treatment that is most successful.

COST OF MAINTAINING

The above figures indicate what a wide diversity of treatment is given to dirt roads, and it is only to be expected that the annual costs of maintenance per mile should vary as greatly. The figures furnished us indicate that the amount spent last year in maintaining graded dirt roads averaged $178 a mile, varying from $13 to $1,250; these figures applying to 92 different counties. More than 25 percent of them, however, lay between the limits of $150 and $350.

Very few figures were obtainable for the cost of maintaining top soil and sand clay roads, but such as we have indicate an average cost for the former of $130 a mile and for the latter of $167.

Quite a number of counties reported on the cost of maintaining gravel roads, which cost ranged from $7 a mile to $1,380, the average



REAR VIEW OF A ROAD PLANE

being $240, nearly fifty percent of them lying between $150 and $350 a mile.

The average cost of maintaining macadam roads as indicated by the table is $353, ranging from $36 to $1,000. Of the figures furnished for maintaining cement concrete roads, one stated that the cost last year was nothing, while another gave it as high as $730 a mile. Only three, however, reported over $300 a mile, and the average of the figures was $203. The figures for maintaining brick pavements varied quite widely, probably because of the fact that a brick pavement has either practically no main-

A PATROL GRADER

tenance cost, or else the figures run very high because certain sections demand relaying of the surface. For instance, Cuyahoga county, Ohio, reported the average maintenance last year as $1,300 a mile on the 277 miles of brick roads in the county, while a county in Illinois reported a cost of only $8 a mile.

Weighting the several costs to allow for the mileage of the different kinds of roads throughout the country, these figures would indicate an average cost of about $200 a mile for mainte-

A MOTOR PATROL

nance. The total mileage is reported at approximately 3 millions, which would give the maintenance cost at about 600 million dollars a year. The mileage represented by our tables is a comparatively small percentage of that of the entire country, and it is quite probable that maintenance is looked after more carefully and expensively, if not intelligently, in the counties reporting, on the average than in those not reporting. It might therefore be reasonable to estimate the amount spent on maintenance of roads other than state highways as between $400,000,000 and $500,000,000 a year. The mileage of state highways is proportionately much smaller; on the other hand, the average cost of maintenance of these highways, which carry a very much heavier traffic, will average much higher than the $200 estimated. The Bureau of Public Roads estimates that the states will spend about $137,000,000 in 1926 in maintaining 234,582 miles, or an average of $584 a mile.

Highway Maintenance Equipment

Practical suggestions by State Highway Engineer of Ohio for equipment for maintaining gravel and macadam roads, grading, cutting weeds, bridge and culvert work, and repairing concrete and brick pavements.

An unusually interesting and comprehensive paper dealing with the subject of the selection and use of highway maintenance equipment was read at the 12th annual road school held at Purdue University on January 19th, by H. J. Kirk, state highway engineer of Ohio. A few of the high spots of the paper are briefly abstracted below.

Highway equipment should be inspected frequently during the working season and completely overhauled during the winter season. "It costs a lot to have a machine break down during the working season and no money is better spent than in the forestalling of breakdowns."

There is considerable complaint concerning the service being given by road equipment manufacturers and much dissatisfaction at hold-up prices for parts and poor service on repair part orders. Mr. Kirk believes that it is good business for a road equipment manufacturer to send out a competent service man—a mechanic with much practical experience and good judgment; and that it is advisable for the State itself to employ a man for general oversight of the highway equipment, his experience in Ohio being that a traveling mechanic for each district or division who is a hard worker and can be trusted, can save his salary many times over. Such a man can spot idle equipment and send it where needed; should have charge of the division garage, and should have the power to discipline any one found abusing equipment in any way.

"There are many reasons for standardizing equipment. With but one make of truck in a district the truck drivers and mechanics learn how best to operate and repair it. Better service can be given because less repair parts need be carried to take care of all needs."

Mr. Kirk then, without naming any special make of equipment, stated his preference for different features of equipment under various heads of grading, cutting weeds, maintaining gravel and macadam, bridge and culvert work, repairing concrete and brick pavements, and others.

Introducing the subject of grading equipment, he stated that if outlying districts and poorer counties had to wait for roads costing $40,000 a mile they would still be in the mud 25 years hence. Ohio has given them all-year roads at an average cost of $3,000 per mile; old roads having been widened out and minor relocations made, repairs made to bridges and culverts, old road metal salvaged and local materials used wherever possible.

The state has found it economical to purchase heavy equipment for this purpose. In hilly country 10-ton crawler-type tractors are worked in pairs, one with a 12-foot blade and the other immediately behind with a 10-foot blade. He prefers the leaning-wheel type of grader because it is free from side-slipping, moves the earth higher and is more easily and quickly pulled out of the ditch. He prefers the track-laying type of tractor in all cases because it is not so apt to tear up the road surface or get mired in bad places. Under some conditions, gasoline shovels are used with three-quarter yard buckets on crawler-type running gear. He considers a gasoline shovel one of the recent outstanding developments in road building equipment for rural highways, believing it far better than the old-time steam shovel for light shovel work because of its lower operating cost and when frequent moves are necessary there is no bother with water lines or fuel transport problems, or in obtaining water which is suitable for boiler purposes.

In rolling or flat country where cuts are long and frequent turns are not necessary the small elevating grader has proved most valuable; it will move an enormous amount of material at small cost. "Under certain conditions I have never seen anything quite so efficient as a small elevating grader for cleaning ditches."

Under the head of roadbed maintenance equipment, he referred to southern and southeastern Ohio where there are many slips and slides, the hills slipping down on to the road or the road sliding down the hill. In such conditions no piece

A ONE-MAN POWER GRADER

of equipment has proven more valuable than a small crane with a clamshell bucket mounted on a truck. For this he much prefers the full circle swinging type for moving slips and slides. A small ditcher originally designed for cleaning farm ditches appeals to him as a good, inexpensive and valuable tool for smaller jobs and dirt handling of this kind. The one-man motor patrol grader is a valuable piece of equipment for shaping up shoulders.

For cutting grass and weeds the best work is done with a farm mower having a 6-foot cutting bar that will cut at any angle between 45 degrees above and 45 degrees below the horizontal. "A machine of this kind pulled by a good team driven by the owner who lives along the road is the best combination for a good, clean, economical job of weed cutting that has ever come to my attention." He has used several types of cutter bars attached to tractors but finds that a team will get into places the tractor cannot, thus reducing to a minimum the work to be done with a scythe by hand.

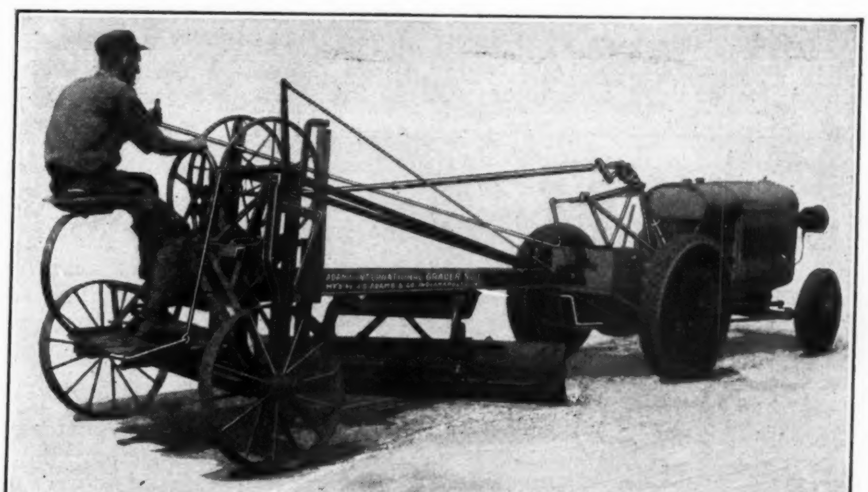
For maintaining gravel and traffic-bound macadam, he states that the loose material thrown off the road by traffic should be kept constantly returned to the center of the road, and the best tool he knows of for this purpose is the spring grader blade mounted on springs and turned to the road surface as a razor blade is to a hone. This spring blade carried along a road at 10 or 12 miles an hour will throw the loose material back to the center of the road, leaving a uniform layer of it there. In addition to this, a large sled drag is indispensable for obtaining a smooth riding surface. It should be used every few weeks and when the surface is in proper condition. With this equipment and correct manipulation of materials a gravel road can be made as smooth for riding as any hard-surface pavement.

For bringing material to the road where it is unloaded from railroad cars, car unloaders and trucks are believed to be necessary. In Ohio, the state contracts with trucking companies for this kind of work at so much per ton, the bid including spreading the material on the road. The working of local gravel deposits is so involved in local conditions that each location is a problem in itself. One very satisfactory piece of equipment for this kind of work is a one-unit gravel crushing, screening and loading plant in which material delivered to a belt conveyor is elevated to screens and oversize material turned into a crusher; the material being finally delivered to a waiting truck by means of a belt conveyor.

"Recently developed equipment valuable in gravel pits includes belt conveyors, bucket loaders, and truck mounted clamshell cranes. Drag line outfits can be used in many places to good advantage depending on the depth, area covered and over burden of the gravel deposit being worked." The best quarry arrangement is where the crusher can be placed much lower than the quarry floor so that stone can be chuted to it. He prefers the gyratory type of crusher because it produces a more uniform size and has low upkeep.

For bridge and culvert work he finds the sand blast and air brush valuable, especially for reaching places otherwise inaccessible. On the other hand, a better job is obtained with the paint brush on surfaces that are accessible. For maintaining concrete bridges and culverts, Ohio uses concrete mixers mounted on rubber-tired trailers, easily portable. The cement gun has been found valuable for economical repairing of certain kinds of masonry abutments.

For maintaining waterbound macadam, the largest piece of equipment used is the motor truck tank distributor for applying bituminous surface treatments. The largest part of macadam road patching today is with bituminous materials. For mixing these, tilting drum type mixers with a skip are preferred because they clean more easily. Mr. Kirk has found the small Fordson type roller a labor saver in places



ANOTHER MAKE OF GRADER

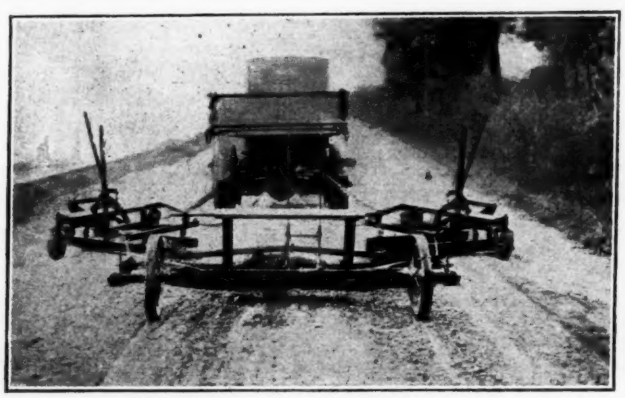
A POWER MAINTAINER

where there is extensive patching. It can be loaded into a truck and transported readily and cheaply from job to job. Heating kettles of two-barrel capacity are well adapted for macadam maintenance. The Ohio department always obtains them equipped with oil burners, which is well worth the extra cost by limiting loafing waiting for the kettle to heat up.

For repairing concrete pavements the air compressor with pavement breaker is the most recent development. A special air hammer mounted on wheels is the best tool he has seen for taking down high spots from raised points on concrete pavements.

Mr. Kirk gave special attention to some outstanding pieces of equipment. The Ford truck is low in first cost and is most economical on hauls up to three miles but over that it fails. A great advantage is the low cost of repair parts and ease of handling. He mentions the small elevating grader, the one-man power grader, the best conveyor for car unloading and cheap handling of materials out of gravel pits. A truck mounted crane does work too small for a large shovel and is readily transportable. The air compressor he considers to have great possibilities, limited only by the development of auxiliary tools; there being already in use paving breakers, air brushes, sand blast, air hammer. air drills, and riveting tools.

For general maintenance work he would buy a 2-ton or 2½-ton truck with pneumatic tires, dump body and hydraulic hoist with full cab. For long hauls over good roads larger trucks may be advisable but Ohio cannot afford to buy them, for haulage contractors will do the work for less than they cost the state. "The best trucks in this class, bar none, in all around reliability and freedom from breakdowns are the Class 'B' Liberty trucks supplied to the states by the federal government."



ANOTHER TYPE OF MAINTAINER, REAR VIEW

Mr. Kirk mentions several needs in the matter of equipment which have not yet been met by the manufacturers. "Motor truck bituminous distributors need wider tires on penetration macadam work. Better heating facilities in the way of a burner made of metal and higher heat-resisting quality and designed to secure more complete combustion will save much valuable time now lost.

"A street sweeper should be provided of more sturdy design than the ones still being manufactured and never intended to be pulled by tractors or moved at high speed from job to job. In general, a better running gear is necessary on maintenance equipment because it very frequently must be moved and moved in a hurry. This applies to belt car unloaders, tar kettles, concrete mixers and other machines."

Better protection against cold should be provided for the operators of trucks, graders, etc. He also favors closed cars for all engineers and superintendents who must drive long distances in all kinds of weather.

A central mixing plant layout for mixing cold patch bituminous materials would meet a popular demand, as would also a central mixing plant for concrete road repair. He suggests a post hole digger to be attached to a Fordson for use in erecting guard rails.

In concluding his address Mr. Kirk said: "Don't tie your money up in expensive equipment unless you have work for it to do. . . . The justification for buying equipment depends on the economy of what it will do as compared with other methods."

"The greatest loss in connection with equipment generally is the loss when it is not working." The purchaser of the equipment must have superintendents with ability to make it earn more than it costs. "No equipment can take the place of a man who has good judgment, initiative, and energy to do things."

A good reason for extensive use of labor saver equipment is that it tends to irritate tax payers to see laborers resting on their shovel handles even for a moment.

Austrian Safety Exhibition

The Austrian Automobile Association announces that it will give an exhibition of the means and measures used or planned in various parts of the world, with the purpose of increasing safety in street and highway traffic, to be held in the city hall of Vienna from May 8th to May 24th. It expects to have on exhibition graphs, posters, leaflets, cartoons, photographs, newspaper clippings, plans, models, etc., bearing on the subject of traffic safety. There will also be a number of lectures with moving pictures or lantern slides.

Sewage Treatment at Bonnie Burn Sanitorium

Imhoff tanks, filter beds and chlorination plant, with capacity for a thousand inmates, replaces old contact beds. Umbrellas on filters and other novel features.

By Louis L. Tribus, M.Am.Soc.C.E.*

The growth of a public institution is like that of most communities, with however a radical difference in the time factor, and generally a greater continuity of management and exercise of paternal power.

On the southern slope of the First Mountain, north of Scotch Plains, N. J., Union County acquired a large, picturesque tract and on it began sixteen years ago the development which now includes many buildings and necessary facilities for an up-to-date tuberculosis sanitorium. This now cares for about four hundred inmates, mostly from Union, but some from other New Jersey counties. At the foot of the slope is the winding Green brook, which eventually finds its way westward through Plainfield. The sanitorium has impounded some of the water of this brook, which after having been passed through a pressure filter, furnishes boiler and fire protection supply, though it is not admitted into the domestic service, whose needs are met by water from a rock well 500 feet deep and the Commonwealth Water Co., of Summit.

While Green brook is not supposed to be used for water supply purposes below the hospital, it is probable that some ice is cut for private use, and bathing in some of its reaches is in summer quite a satisfying feature of neighborhood life.

At the time of starting the hospital in service the sewage was discharged into a pit which had been dug and lined with planks, from which a pump drew the liquid and delivered it upon the ground, up the hill at some distance from the hospital buildings. Crops of corn, grass and pumpkins assimilated some of the sewage, but the excess flowed over the surface of the red hardpan soil, to the brook.

In 1911, Jacob L. Bauer, county engineer, engrossingly busy with his road and bridge work, asked the Board of Chosen Freeholders to retain Tribus and Massa to design a sewage treatment system to protect the brook against direct discharge of raw sewage into it.

The Freeholders acceded to the request, but asked that the design provide for five years use at the most, for it was their intent to contract with the city of Plainfield to take the sewage flow into an extension of the city's sewer system, and thereafter care for its treatment at the city's large plant to the westward.

In view of the few years of prospective use, no change was made in the plant proposed as to the pit, pump or pipe line; though as the years passed, two other pits were dug and pipe line renewal and pump repairs were required.

The design as executed included, at upper end of the pipe line, a roofed regulating and dosing chamber, and two successive groups of three concrete tanks each, used as open contact areas, the sewage level being below top of the broken stone. Automatic discharge was provided in the dosing tank, and also to pass the partially treated sewage from the first to the second group of tanks and thence in turn into underground tiles bedded in and covered with broken stone.

When it received the care which any automatic apparatus requires, the system worked well, though the very tight soil did not take up as much of the flow as was desired. However, the final effluent was clear and colorless and did not carry any particularly offensive odors in its ultimate passage to the brook.

However, the design and construction did not entirely meet the original instruction, in that it savored of permanent rather than temporary character, though not planned for any great increase in tributary population.

About ten years passed instead of the five-year limitation; the Plainfield scheme had failed in negotiation; the automatic apparatus was badly corroded and out of order; the plant was of insufficient capacity for the size to which the institution had grown; and the State Department of Health insisted upon either extending facilities or the building of a new plant.

Again the writer's firm was called upon, in 1921, and there began a very lively controversy between the engineers, backed fully by the county officials, and the State Department of Health, ending finally however, in victory for the latter.

It had seemed an ideal situation in which to install an entirely covered, intensive system by which the raw sewage would be treated with lime as a coagulant, then separated in Dorr tanks and passed into special compartments for sludge and effluent, respectively. The former was to be drawn daily, charged with common salt sweepings, stirred with compressed air, and broken up by electric current: the resulting release of nascent oxygen and formation of sodium hypochlorite would have completely destroyed all organic matter. The clarified liquid carrying solution of lime was to receive as much or as little electric current as might be needed to similarly release the oxygen and thereby render the effluent non-putrescible for a sufficient number of days to permit of brook diffusion without a shadow of nuisance.

On the score that the proposal was of an experimental nature, the State Board would give only such a provisional consent to this plan that no trustees of public monies would have been justified in carrying it out.

It is not the purpose of this article to go into a

*Of Tribus and Massa, consulting engineers, New York City

IMHOFF BUILDING READY FOR TILE ROOF

discussion of the project, but simply to state that real experiments had been satisfactorily made, with every indication of success. This, together with moderate cost of prospective plant, ability to operate equally well in winter as in summer, and occupation of but small space, made it seem a pity to block the enterprise. Furthermore, the process owners were willing to bond themselves to make all subsequent changes that might be shown to be needed, and even to convert the plant into a different form of treatment, if the patent processes failed, without cost to the county.

In 1924, after rather lengthy negotiations, plans were prepared for the system recently put into service, which has cost nearly double the estimate for the other type of plant and has taken many times the area that it would have occupied, with some inevitable letting down of effectiveness during cold weather.

IMHOFF BUILDING AT LEFT, CONTROL HOUSE IN CENTER, SLUDGE FILTER IN FOREGROUND

THE NEW PLANT

Fortunately, gravity flow throughout has been possible, from the outlet of the trunk sewer through the plant to the brook.

A brick building houses a pair of Imhoff tanks each of which will easily take the daily sewage flow from 1,000 patients and operatives (the present total population is about 500). Should the altogether unexpected happen and an even greater population than 1,000 have to be served, the tanks would care for a considerable increase without risking efficiency.

The tank effluent has unrestricted flow (as directed in a control house) to either of two pairs of sand filter beds. (Construction of a third pair has been deferred until needed.)

The sludge is forced out by tank pressure for drying upon its own sand filter.

The drainage from all the filters passes through a 5,000 gallon baffled tank, in which it receives a dose of chlorine from a Paradon outfit which is conveniently housed in a warm room above the tank. This building, like all others, is of brick, with tile roof.

A water system makes possible washing all parts of the plant, and sprinkling embankments to tempt grass to grow, as well as the weeds which have taken very kindly to the site.

The effluent collectors in the filter beds are of tile, but the distributors are cast iron pipes. Here, perhaps, is the only novelty in the system; the distributors are laid on top of the broken stone above the collectors, from which the incoming tank effluent is carried in vertical risers to the surface, where there is attached to each a 16-inch diameter circular spreading plate, and over each plate a Duraluminum umbrella to protect the riser and plate from snow, stones thrown by boys, etc.

Fly screens protect all windows and doors of the several buildings.

Land drainage was completely provided, as also were broken stone access walks.

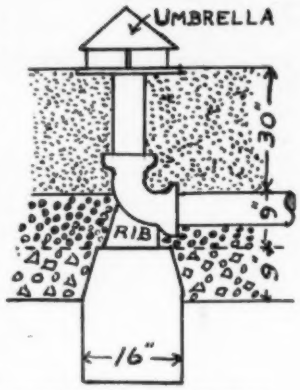
The plant occupies an area of about 500 by 400 feet, which has a fall of about 15 feet towards the brook. The highest elevation is occupied by the Imhoff tanks and sand filters numbers 1 and 2 (which have been left for future construction). About 5 feet lower lie the sludge bed and sand filters numbers 3 and 4; while about 10 feet lower still are sand filters numbers 5 and 6; the chlorine treatment house being at an elevation slightly greater than these last two filters. These elevations refer to the ground surface and not to the surfaces of the filters themselves. The elevation of the flowing sewage in the Imhoff tanks is 261.0; that of the surface of the sludge filter, 255.0. The elevations of the surfaces of the sand filters are as follows: Number 1, 259.0; number 2, 258.5; number 3, 257.0; number 4, 256.5; number 5, 255.0, and number 6,254.5. The elevation of the outlet into the brook is 243.5; numbers 1 and 2 being wholly in excavation, and numbers 5 and 6 largerly on fill.

The lowest point of the hopper bottom of the two Imhoff tanks is elevation 242.7. The lower edges of the sloping bottoms of the sedimentation channels

EXCAVATION FOR IMHOFF TANK IN RED SHALE ROCK. FRAMING FOR FORMS AT BOTTOM

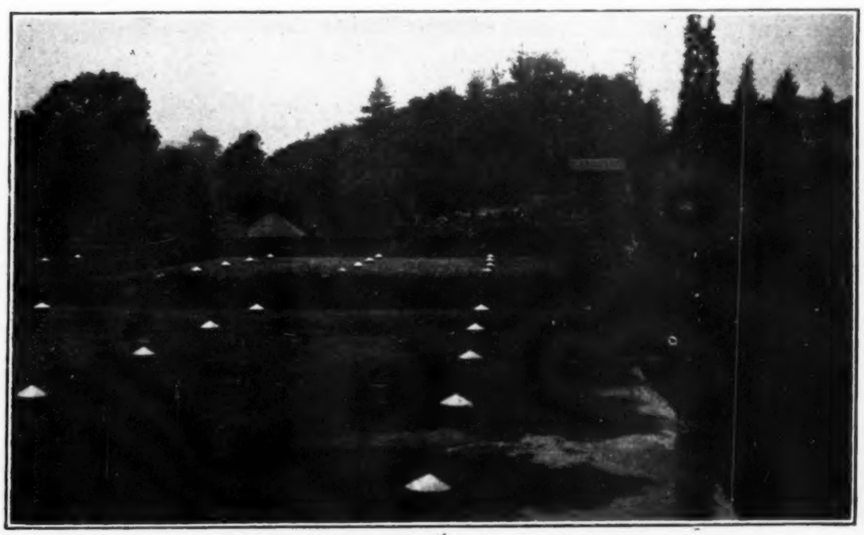
are at 252.0. The channels are 12 feet wide and 28 feet long. On each side of each channel is a gas vent in the form of a slot, 2 feet wide in the clear, thus giving a gas vent area 25 per cent. of the total area of the tank. The horizontal branch of the sludge pipe is about 4 feet below the surface of the flowing sewage. The walls of the tank rise to an elevation 4 feet above the surface of the sewage. In the concrete wall separating the two tanks is a 4-inch cast-iron pipe, which supplies 2-inch lead pipes perforated with ⅛-inch holes 4 inches c. to c. laid along the top of the slopes of the hopper bottoms. The Imhoff tanks are housed in a building 41 by 30 feet inside dimensions, with a tiled roof extending 16 feet above the ground surface and provided with two copper ventilators 3 feet in diameter. Two triple windows on each side and one triple window on each end are provided with vertical ribbed semi-clear glass, the central window of each group being provided with a transom at the top.

The sand beds numbers 1 and 2 are each 100 feet long by 50 feet wide; numbers 3 and 4 are 90 by 55 feet, and numbers 5 and 6 are 100 by 55 feet. In the bottom of each sand bed is first 9 inches of 2½-inch broken stone in which is laid the collecting tile; on top of this is 9 inches of ¾-inch stone screenings; and on top of this, 2 feet 6 inches of fine sand. The collecting tile vary from 8 inches at the outlet to 3-inch branches which are laid in parallel lines 7 feet c. to c. On top of the broken stone are laid cast iron distributors in sizes of 8 inch, 6 inch and 4 inch. Risers are spaced 16 feet 6 inches apart in both directions and are connected to the distributors by means of 4-inch wyes. Each riser consists of a 4-inch elbow and a short section of 4-inch pipe, the elbow being provided with a rib which rests upon a concrete base 16 inches square. The top of the riser is at the elevation of the top of the sand, and cast on its upper end is a horizontal flange one inch thick and 16 inches outside diameter. Resting on this flange is an umbrella of 17 gauge Duraluminum, the lower edge of this raised 2 inches above the flange. There are 18 of these risers or distributors with their umbrellas in each sand bed.



CAST IRON DISTRIBUTOR WITH UMBRELLA

The sludge bed is 40 by 20 feet and is constructed with 12 inches of broken stone, 18 inches of stone screenings and 18 inches of sand. Six lines of 4-inch open-joint tile are laid in the broken stone for drainage. The sludge is admitted to the surface through three 4-inch cast-iron outlet pipes.



SAND FILTERS NOS. 3 AND 4, SHOWING UMBRELLAS. CHLORINATION HOUSE AT LEFT CENTER; CONTROL HOUSE AT RIGHT CENTER

The control house is a small brick building 6 feet by 8 feet outside dimensions, with a flooring of ¾-inch subway grating just above the ground level. Here the sewage enters through an 8-inch pipe and is discharged to any bed desired through other 8-inch pipes provided with shear gates.

SAND FILTER, SHOWING COARSE STONE, ON WHICH REST CAST IRON DISTRIBUTORS

SAND FILTER, SHOWING CAST IRON DISTRIBUTION RISERS WITH SPREADING PLATES ON TOP. TRUSS WAS USED AS RUNWAY FOR PLACING SAND ON BED

CHLORINATION HOUSE; CONTROL HOUSE AT UPPER LEFT HAND

The chlorination plant is housed in a brick building 12 feet square outside dimensions, under which is a tank which extends 10 feet underground beyond the building. This well is provided with one longitudinal baffle, and two transverse baffles in each half; one of these just in front of the outlet, being provided with a weir—a beveled steel plate set in a 6-inch concrete wall. By means of these baffles the sewage, after receiving the chlorine, is thoroughly mixed therewith during a flow of about 35 feet.

The hospital has had the same superintendent, Dr. John E. Runnels, from the start, as well as the station engineer, Mr. Black. Both take an interest in the new plant, and the sanitorium chemist makes frequent analyses of effluents to determine their bacteriological character and consequent necessary dosage of chlorine.

The contractors for the general construction were Mango and Company of Plainfield, while the plumbing and electrical work was installed by A. E. Smith.

The total cost has been about $78,000, excluding land.

Underground Sewage Pump

In an article describing the Seneca-Rogers Sewer district, which lies between the city of Rochester and Lake Ontario, in the "Rochester Engineer," Gloster P. Hevener gave a brief description of a pumping plant for raising the sewage from a low level area.

This area includes about 135 acres and the sewage from it is lifted about 13 feet into a 15-inch gravity sewer. "The pumping station is a subterranean concrete structure about 10 feet by 14 feet in plan and 26 feet deep, located under the parking space with a 4-foot square manhole in the roof to afford access. A fan and vent are provided for ventilating the structure. The building is divided into three stories and the lower two stories are divided by a transverse partition into two compartments, one to serve as a wet well and the other as a dry well.

"The wet well is 6 feet by 10 feet in plan and has an available depth of about 5 feet, making its capacity a little over 2,000 gallons. A bar screen, having an available gross area of about 35 square feet and composed of ½ by 2½ inch bars spaced 2½ inches on centers is provided in one corner of this well. A platform at the level of the first floor is installed for use in connection with cleaning the screens.

"The dry well, which is to be about the same size as the wet well, is equipped with two 425 gallons per minute (610,000 gallons per day) vertical centrifugal sewage pumps (Wood Patent). These pumps are driven by two 5 h.p. Fairbanks-Morse electric motors located on the floor above. These motors are automatically controlled by switches operated by floats in the wet well. A short length of 8-inch cast-iron pipe acts as a discharge from the pumps to the manhole adjacent to the pumping station at the head of the 15-inch gravity sewer. The electric power for operating the pumps is obtained from a main power line of the Rochester Gas & Electric Company in St. Paul Boulevard and is conducted to the station through an underground conduit. In case the power should fail, an overflow from the sanitary sewer to the adjacent 20-inch storm sewer is provided. The elevation of this overflow is about 8 feet above the sanitary sewer and is used only in case of emergency."

Louisville Sewers and Contractors

The following letter refers to an editorial published in our January issue, page 21:

Editor, Public Works, New York, N. Y.

Dear Sir:

Concerning an editorial in a recent issue of Public Works, wherein it was stated that the Commissioners of Sewerage of Louisville could only secure two bidders, we think you should be informed that on this particular project either a deep trench or a tunnel was necessary. A number of contractors figured on the job and found an open cut trench could not compete with tunneling on this particular project. For this reason, only those who were equipped for and were experienced in tunnel work in sand undertook to make proposals. There were two of these, one a local corporation and the other an expert tunnel contractor who has recently moved to Louisville to make this his permanent home on account of the rapid growth of Louisville and the public work in contemplation. Both bids were less than our estimate of cost and were entirely satisfactory to the Commission.

It might be well for you to know we had seven proposals at our letting on February 26th, the low bidder being under our Engineer's estimate of cost and the next bidder only $235 more than the low man. The low bidder on this project is the only contractor who has ever presented appeals from the decision of our engineers to the Commission, which indicates that he is satisfied that he received fair treatment when all the facts were known to him.

Sincerely yours,
P. H. Hoge, Jr.
Secretary & Treasurer, Commissioners of Sewerage of Louisville, Ky.

PHH-RJ

Uniform Wire and Sheet Metal Gauges

It is stated that there are in use in this country thirty wire and sheet metal gauge systems and the confusion resulting from this condition has become intolerable. In order to bring an end to this condition, if possible, a conference was held on March 18th in the Engineering Societies Building, New York City, attended by representatives of twenty-five organizations, at which unanimous decision was reached that this was desirable and a committee was provided for representing all interested industrial groups, under the auspices of the American Engineering Stand-

ards Committee. Opinions generally seemed to favor elimination of all gauge numbers and the substitution for them of a simple system of designating sizes in decimals of one inch. The work turned over to the committee was outlined as follows: "The standardization of a method of designating the diameter of metal and metal alloy wire, the thickness of metal and metal alloys in sheet, plate and strip form and wall thickness of tubing, piping, and casing made of these materials; and the establishment of a standard series of nominal sizes and of tolerances for wires, sheets, plates and strips."

Contract Bonds

In March last a report on the general subject of surety bonding in connection with public works in New York State was made by Sullivan W. Jones, state architect. In investigating the matter, hearings were held in New York and Albany and many reports and other documents were examined.

Some of his conclusions were: That the better class of contractors did not bid on state work because required to compete with irresponsible and incompetent contractors. These bid too low, were awarded the contracts, and either poor work or the failure of the contractor resulted. Not one contract in one hundred is completed in contract time. Surety companies not only go on the bonds of irresponsible and incompetent contractors, but even loan them the 5% bid deposit. Under the present law, method, and form of contract, the bond not only is objectionable for the above reasons, but serves no useful purpose; and the premium of 2 per cent on the bid price is paid by the state.

As a result of this investigation, Mr. Jones recommended that the laws be changed as follows: To "eliminate the requirement that a contractor furnish a bond." That the word "responsible" be defined "as meaning that the contractor shall be able to show assets in excess of liabilities to the equivalent of 15 per cent of the amount of the contract, or that a bank licensed to do business in the State of New York will advance him credit to that amount, and that he shall be able to show he has successfully executed work of similar character and scope." That a contractor be required, in order to qualify for an award of contract, to prove his responsibility as defined above, and that the penal law be amended to include the giving of a false statement to any state department or official. That it be required that "all contracts contain a clause providing for the collection of liquidated damages in the event of the failure of the contractor to complete a contract within the time specified." That "in the event of a bidder failing to execute the contract which has been awarded to him, the sum deposited by such bidder be forfeited as liquidated damages and the board, department, commissioner or officer receiving said deposit shall forthwith deposit the same with the treasurer of the state." That authority be given "to issue a subpoena to any and all bidders, their agents, servants and employees and to interrogate them with respect to any bid submitted by them and to compel the production of any and all books or records necessary for the conduct of such examination" and finally, that "the form of contract be changed to provide for progressively diminishing retained percentages on payments made as the work advances and the state's exposure to loss diminishes, beginning with a retention of 20 per cent on the first payment and decreasing proportionately as the work progresses to 5 per cent on the last payment previous to the final payment, which signifies acceptance of the work."

1925 Zoning Ordinances

Zoning ordinances were adopted during 1925, as reported to the U. S. Department of Commerce, in the cities named below. In most cases it is stated whether the ordinance is for area, use or height of buildings, or comprehends all three of these.

Pine Bluff, Arkansas, use. In California: Petaluma, use; Riverside, comprehensive; San Leandro use and area; Santa Clara, comprehensive; South San Francisco, use. In Colorado: Colorado Springs, use; Denver, comprehensive. In Connecticut: Enfield, comprehensive; Fairfield, comprehensive; Hartford, use; New Britain, comprehensive, and Norwich comprehensive. In Florida: Jacksonville, comprehensive. In Georgia: Savannah. In Indiana: Elkhart, comprehensive; Evansville, comprehensive; Gary, comprehensive; Kokomo use and area; Mishawaka, comprehensive; Valparaiso, comprehensive. In Iowa: Ames, comprehensive; Cedar Rapids, comprehensive; Davenport, comprehensive; Iowa City, use and area; Red Oak, use and area. In Kansas: Manhattan, use; Salina use and area; Topeka, comprehensive. In Louisiana: Shreveport, comprehensive. In Massachusetts: Belmont, comprehensive; Haverhill, comprehensive; Lynn, use; Medford, Needham, New Bedford, Newton and North Adams, comprehensive; Revere and Salem use; Somerville and Stoneham comprehensive; Taunton, use; Wakefield, Walpole, Waltham, comprehensive; Wellesley, use, and Woburn, comprehensive. In Michigan: Ironwood and Kalamazoo, use; Midland, Muskegon, Owosso and Ypsilanti comprehensive. In Minnesota: Duluth, comprehensive. In Nebraska: Fremont, use and area. In New Jersey: Audubon, comprehensive. In New York: Auburn, use; Baldwinsville, use and height; Cayuga Heights, use; Cedarhurst, comprehensive; Glens Falls, use; Kingston, use; Lowville, use; Mamaroneck, comprehensive; New Rochelle, comprehensive; Patchogue, comprehensive; Penn Yan, use; Potsdam, use and area; Seneca Falls, use. In North Dakota: Fargo, comprehensive. In Ohio: Lakewood, comprehensive; Marion, use; Maumee, comprehensive; Oakwood; Warren, comprehensive; Wyoming, comprehensive. In Pennsylvania: Aldan and Beaver, use; Bellevue, comprehensive; Chester, use; Edgewood, comprehensive; Edgeworth, use; Emsworth, Ingram, Monaca and Monessen, comprehensive; Swissvale, use and

area, and Westview, comprehensive. In Rhode Island: Westerly, comprehensive. In Wisconsin: Green Bay, comprehensive, and West Allis, use.

Georgia Investigating Calcium Chloride

Due to the conflicting opinions expressed in the literature of the effects of calcium chloride upon concrete when used as an admixture, the State Highway Department of Georgia is undertaking such an investigation for its own enlightenment. Aside from the question of increased or reduced strength, they wish to establish the effect of calcium chloride upon the setting time of concrete in which various brands of cement are used. It is hoped to determine whether calcium chloride as an admixture will cause some cements to set so rapidly as to interfere with the proper finishing of concrete pavements with machine finishers.

The Department also expects to study further the design of sheet asphalt mixtures, and to investigate the possibility of using several local materials not before used in base courses.

Boonville Water Works

Well supply lifted to reservoir and elevated tank by electrically-operated centrifugal pumps designed to meet increased fire demand and resulting increased friction head, while operating at all times with high efficiency and keeping the electric demand low.

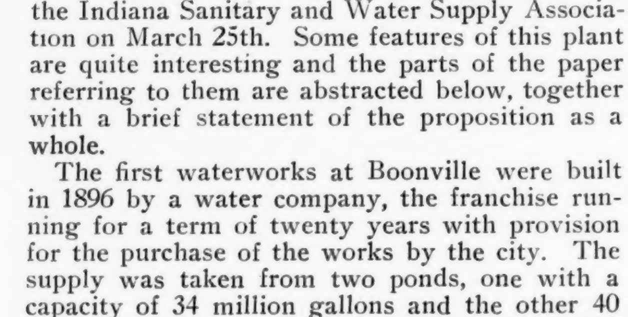
The waterworks system of Boonville, Indiana, was described by the engineer, Charles Brossman, of Indianapolis, in a paper before a meeting of the Indiana Sanitary and Water Supply Association on March 25th. Some features of this plant are quite interesting and the parts of the paper referring to them are abstracted below, together with a brief statement of the proposition as a whole.

The first waterworks at Boonville were built in 1896 by a water company, the franchise running for a term of twenty years with provision for the purchase of the works by the city. The supply was taken from two ponds, one with a capacity of 34 million gallons and the other 40 million gallons. A tank was built of 100,000 gallons capacity elevated on a tower with the bottom of the tank 80 feet from the ground and the top 112. The pumping equipment consisted of a duplex steam-driven pump and an electric-driven centrifugal pump, the latter being located in the electric light plant, so that it could be operated by employees of the plant, thus saving in operating expense.

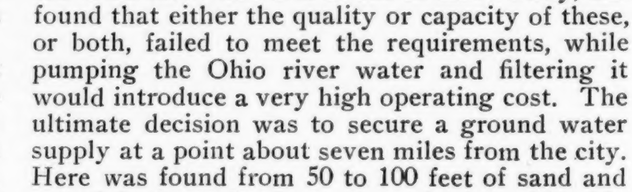
It was recognized some years ago that the consumption was approaching the capacity of the supply as the town increased in size, and plans were made in 1923 for a new supply. Moreover, the original supply, being surface water, was subject to pollution and, although it received chlorine treatment, its safety was not considered to be sufficiently protected thereby; in addition to which it received considerable mine drainage which introduced objectional characteristics.

In studying the problem of a new supply, the engineer considered several streams, including the Ohio river which is about 10 miles away, but found that either the quality or capacity of these, or both, failed to meet the requirements, while pumping the Ohio river water and filtering it would introduce a very high operating cost. The ultimate decision was to secure a ground water supply at a point about seven miles from the city. Here was found from 50 to 100 feet of sand and gravel in irregular layers carrying considerable ground water, the direction of flow of which approximately paralleled the Ohio river. It was believed that this area had once been either a channel of the river or an area periodically flooded from the river and receiving deposits of sand and gravel transported from further up the stream.

The wells that were constructed here were located at a point where the water-bearing gravel is approximately 25 to 28 feet deep and rests upon sandstone about 50 feet below the ground surface. In some of the test wells very coarse deposits of gravel were found for a height of 16 feet, covered with a considerable layer of finer sand. Contracts were let for two 16-inch wells both about 50 feet deep. At the bottom of each well was to be a Cook strainer about 18 feet long and 15 inches in diameter. The strainers were not slotted until after the well had been

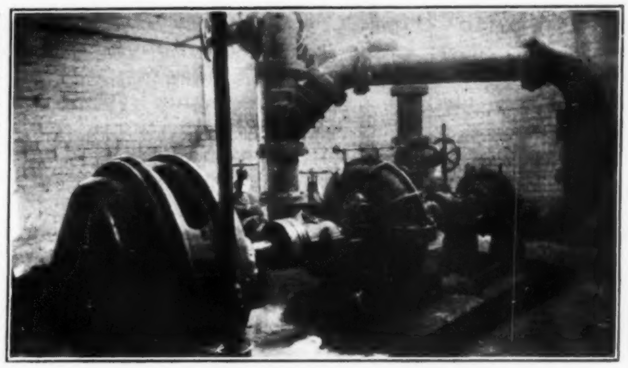


DIAGRAMMATIC PLAN OF PUMPING SYSTEM



NEW 1,500,000 GALLON RESERVOIR

drilled and the depth of coarse water-bearing gravel determined. Then the strainers for each well were slotted to suit the conditions in that well, number 80 to number 100 slots being used where the gravel was coarse, while where fine sand was found the slots were as small as number 14. A 10-inch well was constructed about 300 feet away from each 16-inch well to reinforce the same, as described further on.

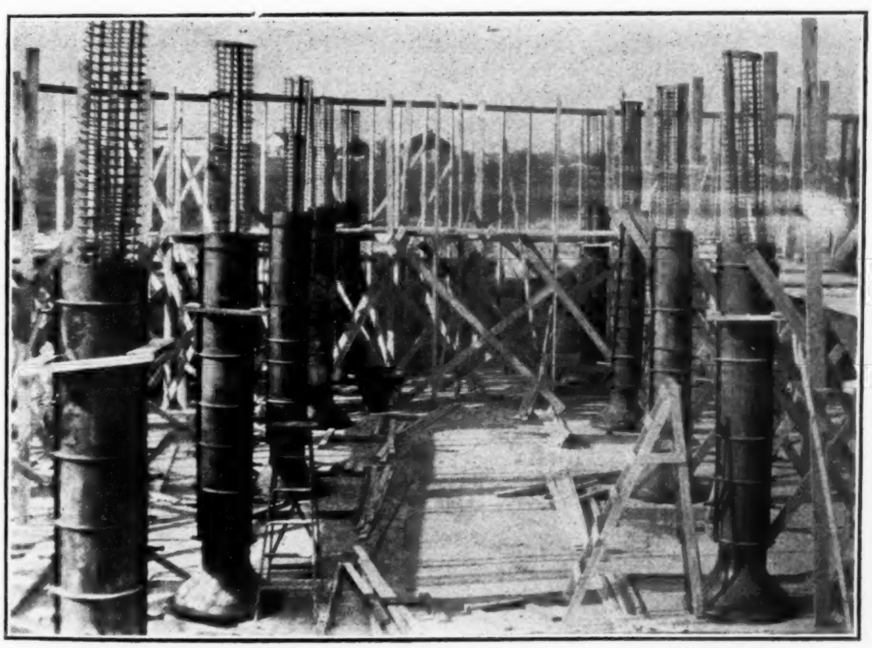


MOTOR, TWO-STAGE AND ONE-STAGE PUMPS AT WELL PLANT

Because of the simplicity of centrifugal pumps, it was desired to use them if possible. When pumping the first well for a test, it was found that the static head of water was approximately 12 feet below the ground, and when pumping about 300 gallons per minute the water was drawn down about 14 feet further. It was planned, therefore, to place the pumps in a pit about 10 feet below the ground surface giving an approximate lift of 15 feet when pumping at a 300-gallon rate or about 20 feet at an 800-gallon rate. The object of the 10-inch reinforcing well, which was connected by a 6-inch pipe with the suction from the 16-inch well, was to permit drawing at a rate of 600 or 800 gallons per minute from each pair without increasing the suction undesirably. With the two wells so coupled an actual test at 800 gallons showed a vacuum of 16 inches at the pump.

CITY PUMPING STATION. FOUR-STAGE UNIT AT LEFT; TWO-STAGE AND ONE-STAGE AT RIGHT

It was decided to use two pumping stations, each drawing from a 16-inch and an auxiliary 10 inch well. In one of these stations is a four-stage 800 g. p. m. pump designed for 250 feet head, operated by a 75-horsepower motor on one end of the shaft and a 90-horsepower Sterling gasoline engine opposite. In the other pumping station is a 600 g.p.m. two-stage pump, operated at a 160-feet head, and on the same shaft is a single-stage pump at 90-feet head arranged to be thrown into service by means of a jaw clutch. These two pumps can be placed in series, thus giving 250-feet pressure to the 600 gallons a minute; while, by throwing out the end pump, this quantity can be delivered against a 160-feet head. It was arranged to have these stations operated by a farmer who lives nearby.



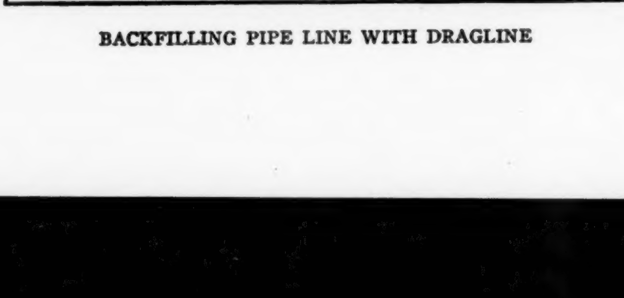
BUILDING CIRCULAR CONCRETE RESERVOIR FOR BOONVILLE
Forms and reinforcement for columns in place

These well pumps deliver the water through about 6 miles of 12-inch pipe to a storage reservoir with a capacity of 1½ million gallons. About one-third of a mile from this reservoir and three-quarters of a mile from the water tower in Boonville is another pumping station in which also there are two sets of pumps, each set practically duplicating one of those at the wells; that is, there is a four-stage 800 g.p.m. 250-feet pump connected to both motor and gasoline engine; also a two-stage and a one-stage pump on the same shaft operated by a motor, these two being arranged for 185 feet head and 65 feet head, respectively. In order to provide for the economical operation of this plant, a new fire station was built at this site, which houses the fire truck, while the pumping plant and workshop are in the rear of this station; and overhead is a five-room dwelling which houses the attendant.

It was estimated that the consumption in 1940 will be about 720,000 gallons per day, an average of 500 gallons per minute. (With the 100,000-gallon tank in service, the maximum rate of pumping from the reservoir to the city for domestic service need not exceed 700 or at most 1,000 gallons.) The Fire Inspection Bureau desired a pumping capacity of not less than 1,400 gallons per minute for fire service. It was calculated that, to furnish the domestic supply at the desired pressure, a pressure head at the pumps at the city plant of 185 feet would suffice. To meet this condition, the two-stage 600 g.p.m. pump was provided. But when 1,400 gallons is being pumped, friction in the mains would raise the pressure to 250 feet. Therefore, the four-stage 800 g.p.m. pump, which will be put into service in case of fire, was designed for a 250-feet head. At the same time the single-stage pump will be connected up to the two-stage pump as a booster, raising the pressure of this unit also to 250 feet.

The same arrangement is provided for pumping from the wells to the reservoir; or, cutting out the reservoir, pumping direct to the city water tower. Here, however, the two-stage pump will act against 160 feet head normally, while the single-stage booster will add 90 feet pressure.

If only high-pressure pumps were used, having a capacity of 1,400 gallons a minute, they could meet the present consumption by pumping only three hours a day, but this would require a very heavy electric demand and a large-size motor. Or, if run at a lower rate for a longer time, the efficiency would be low.



BACKFILLING PIPE LINE WITH DRAGLINE

The combination described gives great flexibility, good economy when pumping domestic supply, and possibility of meeting either fire requirements or increased consumption due to growth. Space is left in each pumphouse for installing future pumps.

Each well is equipped with a Cook foot valve placed below the water line of the well, and while there is a check valve in the discharge line of the pumps, there is also a by-pass around the check so that a small line will always feed around the check and keep the pump primed in case of slight leakage through the foot valve.

The pumps are operated with G. E. synchronous motors with direct connected exciters. The pumps are designed to give approximately full load on the motors when operating at the proposed pressure. The motors are 2,300 volt, three-phase, 60 cycle, using primary current, which, with the synchronous motors, gives the lowest possible electric rate. In each plant the four-stage pump can be operated with a Sterling gasoline motor should there be an interruption of electric service.

The new reservoir is circular, 125 feet in diameter and 18 feet deep, with a capacity of 1,500,000 gallons. It is of concrete, roofed, with columns of mushroom type top and bottom. The floors are 10 inches thick and the roof 6½ inches, each reinforced in three directions. The walls are 16 inches thick with a double row of reinforcing.

A joint ½ inch wide and 6 inches deep was left entirely around the junction between the wall and floor, and later filled with alternate layers of poured asphalt and calked oakum. Also an 8-inch galvanized iron crimped strip was placed half in the floor and half in the wall to prevent leakage.

On the roof of the reservoir was built a reinforced concrete aerator house, having cast-iron baffles set on an incline of about 30 degrees, over which the water coming from the wells is discharged before entering the reservoir.

The reservoir was built by the Roth Construction Co. of Boonville, Ind. The pumps were Dean-Hill. The 800 g.p.m. pumps were connected up to G. E. 75-horsepower motors and 90-horsepower Sterling engines. The 600 g.p.m. were driven by 60-horsepower motors. The pipe was centrifugal pipe furnished by the American Cast Iron Pipe Co. The pipe line was laid by Emil Hartig of Evansville, Ind. The work was designed in the office of Charles Brossman. George T. Gilbert was resident engineer. C. C. Abbott, city engineer, assisted in the surveys and in some of the installation work, which was done by day labor. The entire cost of the plant was about $225,000.

The financing of the work is of interest. A year after the plans had been made (but no action taken on them) the old reservoirs began to lower rapidly and Mayor Thomas Mullin, realizing the need of immediate action, got the three

banks of the city to agree to advance the necessary funds, to be repaid later by sale of bonds. Contracts were let for the pipe and laying and Mr. Hartig laid the 5½ miles in forty days. Before the end of this period the reservoirs were almost empty, in spite of water pumped from an old mine through a temporary pipe line laid on the surface of the ground; and there was a great popular celebration when the well water was turned into the distribution system.

Constructing Extensive Wet Ground Foundations

Sea wall and other structures, some submerged, built on soft meadow mud. Pile driving by submerged steam hammers. Belt conveyor distribution of concrete.

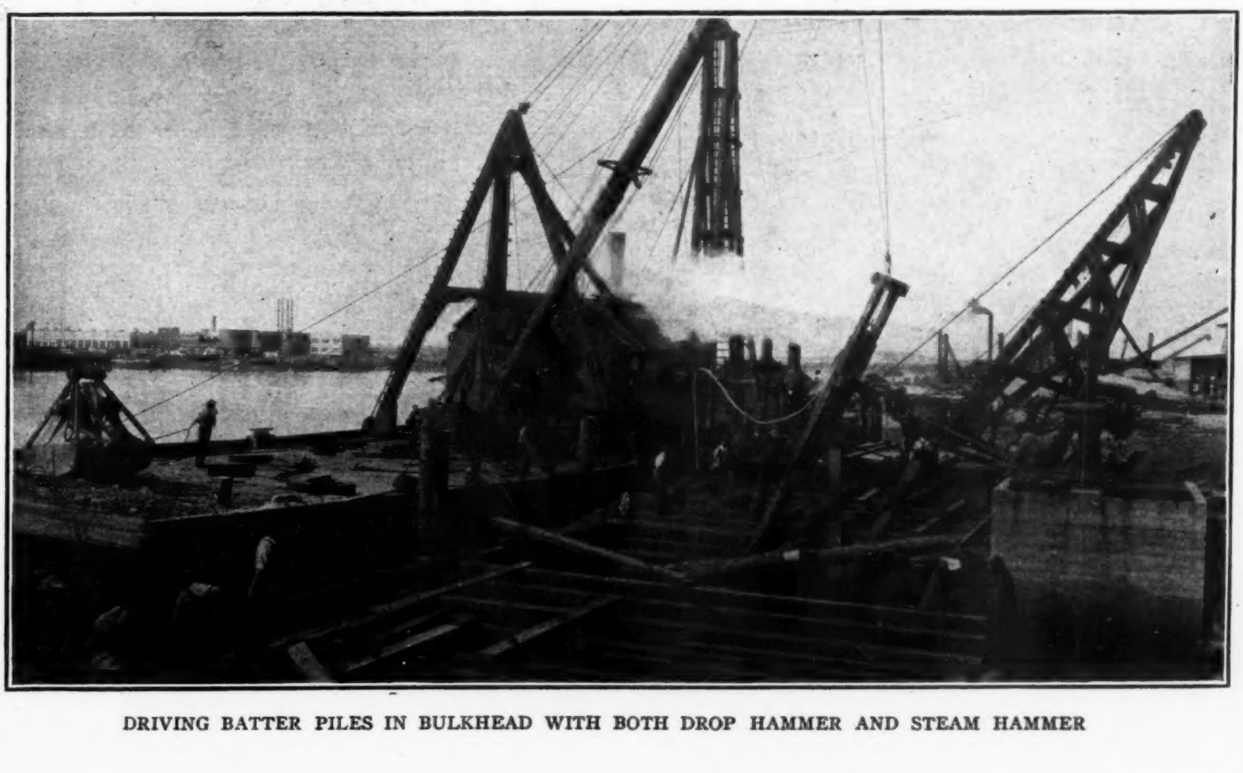
An extensive foundation for a concrete sea wall and other structures is being constructed in marsh land along the Passaic river at Kearny, New Jersey, by the Western Electric Co., which is unusual both for the extent of the work and for some of the features of construction.

The ground is soft and wet, with little surface bearing value, and pile foundations were necessary. The work will require about 200,000 piles up to 60 feet long, designed to carry twenty tons each. Yellow pine is being used and about 40,000 have already been driven. In connection with the construction and the subsequent use of the site, a railroad siding was built to adjacent tracks and 1,800 feet of 40-foot road furnished connections with the state highway. To provide for these, a cinder embankment about 2½ feet high was built on the surface of the marsh. In order to furnish depth of water along the new bulkheads and raise the surface of the marsh, about 300,000 cubic yards of mud and sand were removed by suction dredge from the river bed and delivered a maximum distance of nearly a mile through 22-inch pipe.

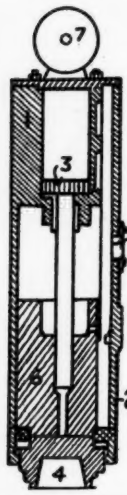
PILE DRIVING

Henry Stears, Inc., the general contractor for the work, provided five floating pile drivers and seven land machines, which were equipped with five 3,000 and 3,500-pound drop hammers and seven double-action McKiernan-Terry steam hammers, several of the latter being equipped for submerged operation, being used whenever possible with the floating equipment that carried telescopic leads in which the hammers could be operated 30 feet below the surface of the water. This use was provided for by furnishing standard steam hammers with inlets which enabled a flexible hose to be coupled to the outer casing that enclosed the moving parts of the hammer and fill it with compressed air which expelled the water and enabled the machine to operate as if in open air. Another flexible pipe discharged exhaust steam above the surface of the water. The anvil block was recessed to receive the head of the pile. Such a machine, with a crew of seven men, made a record of more than 100 piles in a single shift.

Steam hammers only were used for driving and sometimes for pulling the sheet piles and driving



DRIVING BATTER PILES IN BULKHEAD WITH BOTH DROP HAMMER AND STEAM HAMMER



DOUBLE ACTING STEAM HAMMER FITTED FOR SUBMERGED OPERATION

the spur piles in the bulkheads. The latter were driven by means of a land driver tilted so that the leads were at the proper angle; or they were attached to the top of the pile.

About 4,000 piles, about 45 feet long, were driven in the bulkhead, which had a length of 1,725 feet. They were driven in transverse rows, each row braced by three spur piles bolted to the bent caps and longitudinal timbers in the wooden deck, which was 40 feet wide and was fastened to the tops of the piles. Bolt holes were bored and bolts and spikes driven by eight Chicago Pneumatic Company's tools, replacing a considerable number of carpenters or dock builders. A concrete sea wall 9 feet high was built on the edge of the bulkhead, behind which a cinder fill was deposited by Hayward clamshell buckets, unloading the cinders from scows alongside.

Piles for the foundation of a subaqueous condensation water tunnel were driven by submerged hammers to a cut-off grade 8½ to 17½ feet below low tide. They were then enclosed in a coffer dam, the inshore end of which was constructed of wooden sheet piles and the outer end of 14-inch 35-pound arch-web Lackawanna steel piles; the latter also being used for constructing a 64 by 73-foot coffer dam enclosing the foundation piles of a coal and ash handling plant. After the coffer dams had been completed, they were unwatered bv 6. 8 and 10-inch electrically driven centrifugal pumps manufactured by the Lawrence Pump and Engine Co. Piles for the power house foundation were driven by steam hammers operated on floating drivers and were afterward enclosed by an earth dike about 9 feet high which protected them while backfill was placed around them up to the level of the concrete floor slabs. One of the foundations, which contained nearly 9,000 piles, was partly in and partly out of water and piles for the latter were driven to the surface of the ground, which was afterwards excavated to subgrade, while the remainder were driven to the surface of the water and backfill placed around them.

Still other piles were driven 3 or 4 feet below the surface of the ground with ordinary followers and afterwards the ground was excavated by means of three ¾-yard Hayward orange-peel buckets which delivered the spoil into 12 one-yard Koppel and 12 Western cars drawn by locomotives, which dumped it into water 16 feet deep, from which it was reclaimed by a 3-yard dipper dredge and loaded into barges in which it was taken to sea and dumped.

CONCRETE WORK

The substructure work required about 35,000 cubic yards of concrete made of graded sand and gravel and Atlas portland cement. Part of the concrete was mixed in two of the contractor's standard floating plants, each of which was installed on a barge equipped with a stiff-leg derrick with a 40-ft. boom operating a ¾-yard clamshell bucket for unloading sand and gravel from barges alongside into an elevated bin which supplied a one-yard Ransome concrete mixer. Cement was delivered to the mixer platform by a slat conveyor 40 feet long. The mixed concrete was hoisted to the top of a 40-foot tower and spouted through steel chutes supported on an Insley steel truss hinged to a vertical axis in the hoisting tower. The chutes commanded three-fourths of a circular area 160 feet in diameter. The capacity was 750 yards per 8-hour shift.

These plants delivered directly to the concrete sea wall on the bulkhead; also at times supplied a hopper which discharged concrete on to a horizontal conveyor belt 700 feet long supported on a wooden trestle 10 to 15 feet high which extended perpendicular to the shore line and discharged at any point onto a movable conveyor belt 200 feet long which traveled back and forth parallel to the shore line and discharged at any point through a short chute. This combination of conveyors thus commanded all of the foundations within an area 200 by 700 feet from a single stationary concrete hopper.


BUILDING SEA WALL ON BULKHEAD

For another part of the work, aggregate was delivered to a storage bin by a ¾-yard clamshell bucket operated by a derrick and was discharged thence, through a Blaw-Knox measuring hopper, to a 1-yard Ransome concrete mixer that delivered to a hoisting bucket in an Insley steel tower 160 feet high, from which it was distributed through about 600 feet on Insley steel chutes supported from aerial cables and on counterbalanced trusses.

Aggregate for land work was unloaded from

barges by a derrick that deposited it for storage on the bulkheads and afterwards reclaimed it to supply a 20-yard elevated loading hopper, which filled two batch dump cars on a narrow-gauge service track 300 feet long which transported it to the mixer.

The basement floor of the cable plant building is of reinforced concrete 6 inches thick, supported on 978 concrete piers 3½ feet high that are carried on clusters of 4 to 19 piles each. Generally the concrete was placed on a top dressing of sand which covered most of the back fill around the piles. Where the top of the back fill was soft and wet, it was first covered with 3 or 4 inches of concrete, which was allowed to set at least 24 hours and thus form a reliable support for the floor slab and save the time and expense of wooden form work.

McKenzie, Voorhees & Gmelin are the architects of the plant, and the J. G. White Engineering Corp. and C. W. Staniford are the consulting engineers.

Expansion Joints in California

Several of the divisions of the California highway organization have been experimenting with different devices in connection with the construction of expansion joints. A common practice is to make the joint 1½ inches wide by the use of header boards, but it is found difficult to remove the boards while the concrete is still green without damage to the ends of the pavement slabs; while if the boards are left until the concrete sets, it is difficult to remove them at all.

Some of the divisions have been experimenting with metal header plates which make possible a joint with a width of less than one inch. In paving the San Mateo—San Onofre line under the direction of resident engineer W. D. Eaton, a header was developed consisting of three ¼-inch metal plates cut to conform to the proposed cross-section of the pavement and held together by means of six small clips. The two outside plates were constructed in two and the center plate in three parts. The assembled header was held in place temporarily with stakes, while the concrete was poured, tamped and finished in the usual manner, being edged on both sides of the header. In removing the header, the three parts of the center section were pulled out first, using hooks applied to notches in the plate; this section having been oiled before it was placed in position. The two outer plates then fall together readily and are easily lifted out. Such joints have a uniform width from the surface of the pavement to the subgrade. The plates are practically indestructible and when used for a considerable period of time should prove less costly than joints of the wooden type.

Developments in Asphalt Paving

Construction methods recommended by Prevost Hubbard include use of a heavy roller for initial compression, and methods of spreading and raking the "hot stuff" so as to secure uniformity of contour, including use of mechanical spreaders.

Students of asphalt paving during the past few years have become somewhat doubtful of the logic or scientific basis for certain specification requirements for asphalt pavements which have been handed down from an older generation, and are beginning to believe that some of these requirements are unnecessary and others are absolutely objectionable.

DISTRIBUTING CONCRETE BY SYSTEM OF FIXED AND MOVABLE BELT CONVEYORS SUPPLIED BY A FLOATING PLANT WITH HOISTING AND SPOUTING APPARATUS.

The association recently organized under the name of the "Association of Asphalt Paving Technologists," is expected to serve as a clearing house for all new and useful information which will tend to throw light on these points.

Discussing this and other features of asphalt pavement before the Second Annual Conference of the North Atlantic States Highway Officials, Prevost Hubbard, chemical engineer of the Asphalt Association, spoke as follows:

It is desired to direct attention to a few extremely important construction details which frequently are slighted because of failure to appreciate how vital they are in producing a durable and otherwise satisfactory pavement. Observance of these details is very essential in the construction of hot mix asphalt pavements from the standpoint of stability, resistance to scaling, disintegration due to water action and uniformity of contour.

ROLLING

Undoubtedly the most important single construction detail is initial compression; and the use of a heavy roller for first compression of the hot paving mixture cannot be too strongly urged, particularly if the pavement is to be subjected to heavy traffic. In the past it has been customary to roll the fine aggregate asphalt paving mixture, at least, with a relatively light tandem roller, prior to using a heavy roller but this is now known to be far less satisfactory than the practice of using the heavy roller first. A light roller will compact the upper portion of the paving mixture satisfactorily but it fails to compress the lower strata, thereby forming a crust which serves to distribute the lead of the heavier roller later used, to such an extent that thorough compaction throughout the depth of mixture is not secured. Such a pavement if opened to heavy traffic immediately after construction, is much more likely to develop waves and ruts than is a pavement initially compressed with the heavy roller. Even when the heavy roller is used the best results can only be obtained by continuous rolling at a rate not to exceed 200 square yards per hour per roller. This matter is considered to be of such vital importance that during the past year The Asphalt Association has revised its construction specifications, which had previously permitted the use of a lighter roller for initial compression, to read as follows:

While still hot the surface course shall first be thoroughly and uniformly compressed by a power driven roller weighing not less than 10 tons. Subsequent compression may be obtained by a power driven tandem roller weighing not less than 5 tons. Rolling shall proceed at an average rate not to exceed 200 square yards per hour per roller continuous rolling for each roller weighing not less than 10 tons and shall continue until no further compression is possible.

Use of the tandem roller is advisable for diagonal and cross rolling where initial compressing has been obtained with a three wheel roller. Considerable care is required however, to use the three wheel roller to best advantage on sheet asphalt or fine aggregate mixtures. The roller should be backed on to the hot mix and operated very slowly, care being taken not to reverse too suddenly. The large narrow wheels cut into the mixture to some extent but compress it from the bottom up so that reasonably uniform density is secured throughout the entire depth of mixture. The extreme importance of maximum initial compression has been demonstrated by laboratory studies of paving mixtures.

PLACING THE MIXTURE

Uniformity of contour in the newly constructed pavement is the second important construction detail to observe. This, of course, is dependent to a large extent upon the care with which the paving mixture is rolled but even with the best of rolling it cannot be secured unless the material has been properly spread and raked by experienced rakers. The mixture should be combed out throughout its entire depth. A wide-spaced, deep-pronged rake somewhat resembling a potato fork has been used successfully by some progressive contractors and is to be recommended. Where it is necessary that workmen stand at times upon the newly raked material, sandals to the bottom of which are fastened pegs of suitable depth should be worn. In endeavoring to improve the contour of their pavements a number of contractors have found that the use of lutes about five feet in width are of material assistance.

An improved method of placing the mixture has also been adopted with good results. This method consists in spreading the mixture so as to produce a working edge in the form of an inverted V with the apex at the center of the road. The rakers can then stand within the V and rake the mixture diagonally toward the center, thus entirely eliminating the tendency to produce raking corrugations at right angles to the center line, which are sometimes noted when the working edge is carried directly across the pavement. When the V-shaped method of spreading is adopted it will be found advantageous to roll the pavement along lines paralleling the sides of the V after the roller has rolled a single longitudinal strip along each side of the road. Such rolling also tends to prevent the formation of construction corrugations.

Mechanical spreaders have been used successfully in the construction of certain types of hot-mix asphalt pavements and it is probable that they will be used more extensively in all types in the future. A special form of tamping roller has also been devised for the purpose of increasing initial compression but the use of this device is still in an experimental stage.

One of the most recent developments in connection with "black base" construction which has been sufficiently tried out to warrant recommendation is the use of mechanical spreaders for distributing the hot mix. Mechanical spreaders may be used economically not only for spreading a uniform layer of mixture across the roadway, but for spreading narrow strips along the sides of old roads which are to be widened. In such work it has been found possible to spread as much as 400 tons of mixture per day with a force of only four shovelers and three rakers. A most interesting and instructive paper describing and illustrating the use of mechanical spreaders in "black base" work, by J. C. McLeod, division engineer of the California State Highway Department, was published in the June, 1925, issue of "Public Works."

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CONTENTS

Gravel and Crushed Stone in Highway Work

Of all materials entering into all kinds of road improvement (except dirt, sand-clay, top-soil and the like), gravel and crushed stone constitute by far the largest part. Gravel and macadam roads consist almost entirely of gravel and crushed stone, and more miles of these are built each year than of all others combined. Bituminous macadam and bituminous concrete contain almost as much gravel or stone per cubic yard as does plain macadam; each yard of concrete contains one-half to one cubic yard of coarse aggregate; and there is more coarse aggregate in the base of brick or sheet asphalt pavement than there is surface material, whether the base be concrete, black base or macadam.

Figuring two ways from two sets of statistics, which brought results within ten per cent of each other, we calculate that last year about 16 million cubic yards of gravel was used in constructing gravel roads, and 35 million cubic yards of gravel and crushed stone in constructing other kinds of roads.

These figures indicate the importance of gravel and crushed stone in road work. Where cement, asphalt or tar are used, they serve chiefly to bind the stones together (also to exclude water), practically all of the wear coming on the stone; and in bases covered with a wearing surface, the stones must carry the weight of the traffic without crushing. Wherever a surface stone in a cement or bituminous concrete road crushes or shatters, it works out, leaving a hole which is enlarged by traffic or frost. If the stones abrade at different rates, depressions form and the surface becomes rough. If the stone is porous, the moisture it absorbs freezes (in northern localities) and it disintegrates. From none of these results can the stones be saved by the portland or bituminous cement that surrounds them.

In view of the above, it seems to us that too little importance is attached to the selection and inspection of stone and gravel. Generally the specification is limited to a paragraph, and the inspection to the features of size and cleanness. Not a tenth part of the study that has been devoted to portland cement or asphalt has been given recently, under advanced methods of investigation, to studying the effect upon road construction and wear of the hardness, toughness, abrasiveness, porosity and other characteristics of rocks, and the sizes of the particles of aggregate.

Anticipating the Future

In the 1925 report of the water department of the city of Hoisington, Kansas, the statement is made that "The present pumping unit is oversize and inefficient. It is the recommendation of the management to install a smaller unit of sufficient capacity for the requirements, thereby reducing the pumping cost about 25 per cent and at the same time providing auxiliary equipment, using the present unit as a stand-by for an emergency. It is figured that a new unit can be paid for by the savings in pumping cost in six months' time."

No engineer, of course, would think of planning any public utility in a growing community with a capacity sufficient for the requirements

of the present only. Estimates of growth of population and the requirements dependent thereon are made, usually for 25 to 50 years ahead, and the utility planned to meet such requirements. But it has long been our opinion that this anticipation of future requirements is frequently overdone. Because a piece of machinery, for instance, may be expected to give efficient service for 25 years is not sufficient reason for giving it a capacity which will be sufficient 25 years hence.

There are at least two good reasons for this. One is, that the present operation will generally be much less economical than if the machinery were of a capacity more nearly equal to the immediate demands; and the consequent monetary loss during its life may easily amount to more than the ultimate saving secured by deferring for twenty-five years the necessity for duplicating the machine or replacing it with a larger one. Moreover, the excess first cost of the larger machine, over that of a smaller one which would suffice for say only ten years, if placed at compound interest would probably go far toward paying the cost of duplication or replacement at the end of the shorter period.

The other argument against providing for too distant a future is that it may well occur that, during the life of the machine, more efficient equipment may be invented for performing the same service; in fact, it has frequently happened that it paid to scrap a machine only five or six years old in order to replace it with one of greater efficiency. In case the size had been excessive, not only would the sum lost in scrapping the machine be unnecessarily large, but there undoubtedly would have been a loss of money every year in excessive operating cost.

The length of the period which it will be wise to anticipate in planning a utility will of course depend to a large extent upon the nature of such utility. For instance, a reservoir built 100 years ago is probably giving as good service today as one built only a year ago, and the cost of maintaining a reservoir of excessive capacity is little greater than that of a small reservoir. So that about the only financial item on the debit side would be the interest on the original first cost.

But this illustration serves to suggest one of the other features to be considered in any study of this kind, in that the larger the reservoir, the greater the loss of stored water through evaporation. In an instance which the writer has in mind, a large distributing main was planned to be laid through a city with a view to serving for fifty years ahead the anticipated growth toward the west; whereas, the city's growth did not follow the expected route but advanced toward the northwest; so that the full capacity of the main furnished was never called upon, but a new main had to be laid in the direction of actual growth.

Instances could be multiplied, each bringing out some new argument of greater or less weight against providing for too distant a future in the planning of public utilities.

Volumes of "Municipal Journal" Wanted

We have an inquiry for complete volumes of Municipal Journal Nos. 28 to 47 inclusive and of Public Works volumes 48, 49 and 50.

If any of our readers have these volumes and desire to dispose of them, they are asked to write us, stating price wanted.

Quick Hardening Concrete for Gary Streets

In the article "Rebuilding Broadway in Gary" in our February-March issue, it was stated that calcium chloride was used in the concrete to accelerate the hardening and permit early use of the pavement in repaving some of the streets of that Indiana city. The manufacturers of "Cal" write us that that material was used in this work, and that, while it can be used under a specification calling for calcium chloride (as did that for the Gary work), it is actually the oxychloride of calcium, in a form quite different from that of calcium chloride as generally considered. Mr. Cottingham, the author of the article referred to, confirms this statement.

Fine Grading for Concrete Pavements

Cost of excess thickness of concrete due to failure to accurately finish subgrade.

Under the title "Increased Cost Due to Improper Fine Grading Methods," C. J. Moritz, president of C. J. Moritz, Inc., of Effingham, Ill., presented at the convention of the American Road Builders' Association facts, figures and tables showing what the loss is to a contractor for each inch of excess thickness of concrete due to uneven surface of sub-grade.

The present tendency being, said he, to require that the specified thickness of concrete be the minimum thickness allowed, the matter of preparing subgrades is of prime importance to the constructors and they are forced to consider seriously how much additional expense is justified in so preparing the subgrade as to avoid the added expense of building a pavement thicker than specified.

"The question resolves itself into two divisions: First—the most economical method of preparing the subgrade, taking into consideration the materials in the subgrade, interference with other operations, and protection of the subgrade when completed. Second—the effect of carelessly prepaid subgrade upon the cost of extra materials and labor required in the construction of the pavement."

Mr. Moritz believes that the use of the mechanical subgraders is the most economical method where conditions permit it. Also, that at least 500 feet of subgrade be kept completed ahead of the mixer. The maintaining of this involves the

question of equipment for bringing aggregate to the mixer; especially truck vs. industrial track.

"From the records of the Illinois State Highway Department we have made a comparison of the actual slab thickness as constructed for a theoretical six-inch pavement by twenty truck jobs and twenty industrial jobs during the 1925 season. These sections were picked at random and presumably represent various degrees of efficiency in road building operations. The average thickness obtained by the truck outfits was 6.499 inches, or practically 6½ inches. The average thickness obtained by the industrial railway outfits was 6.418 inches. Further analysis of these figures was that the maximum and minimum excess thickness under both forms of hauling were practically the same. There seems to be a slight advantage in the industrial operations. This difference, however, is so small that it becomes practically negligible in so far as these forty jobs are considered."

Concerning extra cost of excess thickness, he said: "The individual contractor must determine for himself his practical cost of subgrading. He should likewise determine for himself the cost of material on his particular job, analyze the same and determine to what refinement he may economically work to save the additional cost of materials and the handling thereof and maintain practical and economical sub-grading operations."

From analysis of cost which he had prepared, assuming the cost of cement at $2.50 a barrel net, coarse aggregate $2.00 per ton and fine aggregate $1.50 a ton, he figured the cost of materials per square yard 1 inch thick as follows: For 1:2:3 concrete, cement 12 cts., coarse aggregate 5.4 cts., and fine aggregate 3.3 cts.—a total of 20.7 cts. For 1:3:6 concrete the respective figures are 7 cts., 6.4 cts., and 2.9 cts.—a total of 16.3 cts. Labor, hauling, overhead and general he figured at 8.3 cts. for 1:2:3 concrete and 8.1 cts. for 1:3:6 concrete. This gives a total of a little less than 30 cts. per square yard for each inch thickness.

"The average excess thickness seems to be about one-half inch. If this be the case and the constructor's cost of materials and labor are approximately as assumed in these tables, then he has additional expenses of approximately 15 cts. per square yard." This is about $1,500 a mile for 18 ft. road.

"There is, of course, a limit to the amount of refinement that should be exercised on the subgrade. I think you will agree with me in the statement that no machinery at present available will produce and maintain a subgrade within less than ¼ inch of a given thickness, especially when it is customary to allow ¼-inch variation in the finished surface of the pavement. To obtain a minimum thickness of six inches as required by recent specifications, it is therefore necessary to lay at least 6¼ inches and unless extreme care is used in preparing the subgrade and keeping all finishing machines and subgrader templates adjusted to their proper relative positions, the resulting thickness will be nearer 6½ inches or more. If now, in addition to the natural barriers to economy in this direction, we add careless subgrading, the resulting expense assumes astonishing proportions.

"To intelligently and economically produce a subgrade to practical refinements, therefore, the following conditions must be given careful study:

"**First,** the possible effect of the hauling equipment upon the subgrading operations, taking into consideration, of course, the other elements and conditions surrounding your particular problem.

"**Second,** the proper equipment necessary to produce your subgrade depending upon the soil and materials with which you must contend.

"**Third,** after due consideration has been given cost of materials, labor, hauling and other expenses as compared with the actual cost of preparing the subgrade, the constructor must determine for himself the economical plane and degree of accuracy to which it is desirable to prepare the subgrade."

County Highway Work in 1925

Statistics from more than three hundred counties in all parts of the country, showing for each the amount and cost of each kind of road improvement made during the year 1925 and the cost of maintaining the roads in the county; also the total amount spent on road work and sources of funds.

The tables on the following pages have been prepared from information furnished to Public Works during the past month by highway officials of more than three hundred countries. The general information concerning amount and cost of work done is similar to and comparable with that published by us in previous years. In addition to this we have obtained special information concerning earth roads, which form by far the largest parts of the roads of the country. This information was furnished in response to the questions: "Kind of soil over which roads pass." "Miles of graded earth roads." "Average width of graded sections." "Average crown." "Mileage kept in condition by dragging, etc." "What equipment is used in keeping surface even?" "How often, on the average, is this equipment used on a given stretch of road?" "What percentage of the time does a road so treated

(*Continued on page* 145)

County Highway Appropriations

Amount spent on highways in 1925 under county or state supervision

County	County appropriations	State appropriations	Federal appropriations	Other appropriations	Total amt. available for 1926
Arkansas:					
Conway	$15,000	$38,000	.....	.....	$50,000
California:					
Fresno	140,000	.....	.....	.....	140,000
Plumas	None	.....	.....	.....	131,000
Colorado:					
Routt	80,000	18,000	$50,000	.....	125,000
Saguache	45,000	38,000	.....	.....	57,000
Florida:					
Bradford	60,000	.....	.....	.....	600,000
Charlotte	225,000	300,000	None	None	1,710,000
Flagler	20,000	5,000	None	None	500,000
Sarasota	.....	.....	.....	.....	2,500,000
Georgia:					
Spalding	21,877	1,672	23,497	.....	62,500
Idaho:					
Idaho	None	115,500	234,500	.....	240,000
Twin Falls	112,000	None	None	.....	82,000a
Illinois:					
Carroll	37,000	367,000	None	.....	300,000
Cass	35,000	20,000	.....	.....	55,000
Champaign	600,000	.....	.....	.....	60,000
Douglas	.....	.....	.....	.....	190,000
Du Page	814,157	.....	.....	.....	100,000
Greene	30,000	.....	.....	.....	30,000a
Henderson	15,000	.....	.....	.....	15,000
Jasper	15,000	370,000	.....	.....	150,000
Johnson	8,000	None	None	None	10,000
Kane	150,000	.....	.....	$250,000	400,000a
McDonough	60,000	.....	.....	.....	.....
McHenry	57,000	756,000	.....	136,000b	186,000c
Macoupin	58,123	.....	.....	.....	54,000
Menard	48,915	.....	None	None	.....
Pulaski	10,000	.....	.....	25,000	35,000a
Richland	15,000	None	None	.....	15,000
Sangamon	100,000	.....	None	200,000	300,000a
Wabash	17,000	None	None	85,000	150,000
White	16,000	383,000	.....	75,000	.....
Whiteside	53,000	None	None	None	.....
Williamson	40,000	.....	.....	70,000	135,000
Woodford	.....	.....	.....	.....	40,000a
Indiana:					
De Kalb	52,000	7,500	.....	.....	85,000
Hancock	.....	.....	.....	.....	90,000
Jay	74,000	.....	.....	.....	62,000
Kosciusko	24,364	.....	.....	.....	.....
La Grange	.....	.....	.....	.....	30,000
Putnam	154,000	.....	.....	.....	141,000
Iowa:					
Bremer	23,741	.....	.....	.....	163,000
Calhoun	91,740	.....	.....	.....	148,000
Cherokee	.....	.....	.....	.....	180,000
Chickasaw	88,742	64,358	.....	.....	.....
Davis	62,000	55,000	.....	.....	115,000
Decatur	35,000	80,114	.....	.....	125,000
Delaware	30,000	30,000	.....	.....	.....
Des Moines	60,000	21,000	d	None	120,000
Dickinson	.....	.....	.....	.....	110,000
Dubuque	54,000	50,000	.....	125,000e	170,000
Emmet	36,220	31,601	.....	40,889	187,416
Fayette	82,750	86,000	e	.....	143,000
Minnesota—Continued					
Stearns	$125,000	$29,000	.....	.....	$140,000
Steele	60,000	19,000	.....	.....	88,000
Stevens	30,301	19,710	.....	.....	60,000
Swift	74,800	20,000	.....	.....	80,000
Washington	57,387	379,197	.....	.....	115,000
Watonwan	70,000	20,000	.....	.....	95,000
Wilkin	103,260	.....	.....	.....	102,000a
Mississippi:					
Jefferson Davis	25,000	25,000	None	$28,000	50,000
Jones	150,000	.....	.....	60,000	530,000
Lafayette	25,000	.....	.....	.....	500,000
Stone	125,000	.....	None	.....	40,000
Winston	120,000	.....	$120,000	.....	.....
Missouri:					
Cole	.....	.....	.....	.....	54,000
Holt	.....	.....	.....	.....	50,000
Marion	80,000	.....	.....	.....	80,000
Mississippi	20,000	160,000	.....	.....	120,000
Monroe	40,000	150,000	None	.....	195,000
Newton	.....	.....	.....	.....	2,500
Pulaski	23,000	.....	.....	.....	25,000
Putnam	.....	26,000	.....	.....	28,000a
Scott	37,000	.....	.....	.....	40,000a
St. Clair	34,500	12,000	.....	6,000	26,000
Washington	15,000	.....	.....	.....	.....
Montana:					
Beaverhead	60,000	None	None	None	75,000
Gallatin	116,000	2,350	95,100	.....	200,000
Golden Valley	11,000	9,110	.....	.....	20,000
Hill	3,500	3,500	.....	.....	40,000
Lake	38,000	1,500	None	.....	40,000
Nebraska:					
Butler	75,000	30,000	30,000	.....	100,000
Loup	.....	35,000	35,000	.....	.....
Sarpy	80,000	8,000	20,224	.....	300,000
Nevada.					
Eureka	.....	.....	.....	.....	40,000
White Pine	68,595	22,000	136,000	.....	250,000
North Carolina:					
Washington	15,000	25,000	None	None	15,000
No. Dakota:					
McLean	63,851	4,319	8,638	.....	120,000
Mountrail	35,000	.....	20,000	.....	60,000
William	40,000	10,000	.....	.....	.....
Ohio:					
Brown	100,000	.....	.....	.....	.....
Cuyahoga	1,312,163	139,653	15,000	885,358	3,500,000
Darke	117,000	.....	.....	.....	200,000
Defiance	173,803	26,873	76,764	.....	.....
Holmes	None	None	None	None	140,000
Jefferson	400,000	300,000	225,000	430,200	500,000
Le Flore	156,215	95,000	165,000	165,000f	425,000
Logan	100,000	60,000	.....	.....	250,000
Medina	.....	.....	.....	.....	350,000
Morgan	30,000	100,000	10,000	3,000	137,000
Muskingum	75,000	50,000	.....	50,000	200,000
Preble	174,000	10,000	.....	.....	.....
Williams	65,000	300,000	9,000	.....	180,000
Wood	312,500	40,000	30,000	.....	800,000

Fremont	76,000	30,000	None	None	125,000
Grundy	80,000	85,000	30,000	.....	100,000
Howard	70,000	30,000	.....	.....	140,000
Jones	42,000	80,000	20,000	.....	145,000
Kossuth	67,000	128,000	20,000	20,000	140,000
Lee	47,000	40,000	.....	45,000	136,000
Lyon	.....	.....	.....	.....	100,000
Marion	34,046	105,000	e	.....	130,000
Marshall	40,000	705,000	e	80,000	123,000
Mills	70,000	25,000	.....	.....	160,000
Monona	34,810	.....	.....	.....	150,000
Muscatine	35,039	77,444	1,990	30,000	.....
Palo Alto	55,000	68,418	2,502	.....	200,000
Scott	67,876	491,383	e	46,691	572,000
Taylor	87,164	.....	.....	.....	150,000
Union	.....	.....	.....	.....	125,000
Kansas:					
Anderson	38,343	12,176	None	.....	97,000
Barton	34,705	7,184	17,354	.....	210,000
Crawford	200,000	50,000	25,000	.....	300,000
Hamilton	2,000	2,500	None	None	27,000
Harvey	.....	.....	45,000	.....	80,000
Haskell	16,000	None	None	None	45,000
Hodgeman	35,914	3,155	None	1,108	60,000
Jackson	.....	.....	.....	.....	136,000
Miami	140,000	None	30,000	None	200,000
Pawnee	.....	.....	.....	.....	120,000
Riley	105,000	.....	.....	.....	125,000
Rooks	38,161	14,608	14,081	.....	75,000
Maryland.					
Kent	25,000	15,000	None	None	10,000
Michigan:					
Branch	150,000	50,000	.....	.....	580,000
Calhoun	27,223	100,000	None	90,000	150,000
Chippewa	.....	.....	.....	.....	200,000
Dickinson	135,000	None	.....	.....	143,000
Houghton	54,358	71,141	None	None	100,000
Isabella	22,000	26,000	.....	20,000	97,000
Keweenaw	25,000	30,000	.....	.....	.....
Leelanau	51,000	32,000	.....	.....	30,000
Monroe	130,288	23,150	.....	.....	173,691
Ogemaw	.....	.....	.....	.....	35,000
Minnesota:					
Beltrami	25,000	19,200	None	None	95,000
Benton	35,000	20,000	.....	.....	55,000
Blue Earth	134,000	28,000	.....	.....	179,000
Brown	92,889	.....	.....	.....	122,000
Carlton	114,000	337,710	e	125,000	795,000
Cass	.....	.....	.....	.....	50,000
Chippewa	60,000	20,000	.....	58,973	150,000
Cottonwood	.....	.....	.....	.....	90,000
Dakota	203,961	.....	.....	31,862	184,650
Dodge	56,611	19,710	.....	.....	125,000
Faribault	160,746	62,372	.....	.....	200,000
Goodhue	150,000	23,000	.....	.....	220,000
Grant	.....	.....	.....	.....	60,000
Houston	69,628	20,000	.....	.....	20,000
Hubbard	15,000	20,000	.....	.....	33,000
Jackson	147,678	22,000	None	None	140,000
Lake	25,000	20,000	10,000	None	50,000
Lincoln	40,000	19,710	None	18,542	52,639
McLeod	95,000	175,000	.....	.....	95,000
Mahnomen	.....	.....	.....	.....	22,000
Marshall	.....	15,768	None	.....	120,000
Martin	99,339	.....	.....	.....	100,000
Nobles	205,990	.....	.....	.....	228,254
Olmsted	115,390	17,912	None	None	155,639
Otter Tail	200,000	28,000	.....	.....	223,000
Pennington	30,000	20,000	None	None	50,000
Pine	.....	.....	.....	.....	87,000
Pipestone	53,000	20,000	.....	.....	50,000
Redwood	.....	.....	.....	.....	97,000
Rice	.....	.....	.....	.....	185,000
Rock	59,571	.....	.....	.....	73,934
Roseau	8,020	9,621	.....	.....	60,000
Sherburne	20,000	22,210	.....	.....	42,577
Sibley	109,098	107,200	.....	.....	216,008
Oklahoma:					
Craig	58,000	.....	.....	.....	......
Tillman	350,000	.....	.....	.....	......
Oregon:					
Douglas	260,000	100,000	200,000	.....	500,000
Lincoln	60,000	24,000	12,000	28,000	118,000
Washington	148,587	.....	.....	.....	163,000
Yamhill	35,000	35,000	e	50,000	......
Pennsylvania.					
Carbon	150,000	None	None	None	......
Erie	600,000	80,000	.....	60,000	206,000
So. Carolina:					
Greenwood	85,000	38,000	63,000	.....	165,000
So. Dakota:					
Buffalo	33,000	5,575	4,000	.....	5,000a
Faulk	30,000	4,500	4,500	.....	40,000
Haakon	40,000	28,000	.....	.....	50,000
Hutchinson	125,000	50,000	50,000	.....	220,000
McCook	35,166	37,157	37,157	.....	75,000
Pennington	153,073	49,984	35,937	.....	161,000
Roberts	12,000	30,000	7,000	.....	......
Spink	40,000	45,000	45,000	60,000	80,000
Texas:					
Bee	12,000	.....	.....	.....	60,000
Brooks	163,000	.....	.....	.....	600,000
Denton	.....	.....	.....	.....	185,000
Ellis	457,685	.....	15,000	.....	300,000
Gonzales	.....	.....	.....	.....	400,000
Jim Hogg	.....	.....	.....	.....	75,000
Matagorda	136,000	36,000	48,000	20,000	......
Maverick	70,000	50,000	.....	.....	75,000
Navarro	100,000	None	None	.....	None yet
Parmer	2,500	3,000	.....	.....	10,000
Red River	.....	.....	.....	.....	118,000
San Augustine	20,000	14,000	.....	6,000	......
Taylor	.....	.....	.....	.....	1,350,000
Walker	.....	.....	.....	.....	600,000
Williamson	84,600	199,400	81,500	5,500	350,000
Wilson	312,000	225,000	450,000	.....	None
Washington:					
Adams	191,000g	24,000	.....	.....	124,000
Clallam	217,000	100,000	.....	.....	250,000
Ferry	.....	177,000	76,000	.....	210,000
Franklin	110,000	.....	.....	.....	125,000
Lincoln	140,000	80,000	.....	5,000	295,000
Skagit	86,366	54,758	.....	.....	......
Skamania	.....	.....	.....	.....	80,000
Thurston	183,572	15,000	.....	.....	277,000
Whatcom	195,400	228,807	152,540	.....	......
Whitman	320,000	150,000	150,000	.....	375,000
West Virginia:					
Gilmer	60,000	150,000	.....	.....	990,000
Mineral	90,000	140,000	.....	.....	250,000
Wisconsin:					
Ashland	6,500	52,000	60,000	10,000	175,000
Bayfield	50,067	61,057	60,000	2,020	158,000
Dane	620,803	183,000	.....	.....	1,611,408
Douglas	135,300	75,508	.....	.....	335,000
Rock	70,767	133,603	140,598	267,719f	453,990
Waushara	40,000	5,000	.....	1,500	110,000
Wyoming.					
Campbell	27,445	.....	.....	.....	30,000
Sheridan	52,710	117,480	176,220	.....	84,000

a—County only. b—Township. c—County and township. d—Included in state appropriation. e—Bridge appropriation. f—Bonds. g—All appropriations.

Graded Roads Constructed in 1925

County	Constructed during 1925 Miles	Cost	Total in the county at the end of 1925
California:			
Fresno	....	....	134.5
Plumas	....	....	400
Routt	....	....	800
Colorado:			
Saguache	20	$15,000d	20
Florida:			
Bradford	25	50,000	130
Charlotte	....	....	50
Idaho:			
Idaho	....	....	500
Twin Falls	16	....	31
Illinois:			
Carroll	25	54,000d	44
Douglas	..	....	406
Greene	....	....	110
Henderson	500	....	....
Macoupin	257	....	....
McDonough	28.5	....	....
McHenry	....	....	50
Menard	102	4,080e	378
Pulaski	5	7,500d	365
Richland	45	....	110
Sangamon	12	5,000e	800a
Wabash	5	8,000e	....
White	700	20,000e	900
Indiana:			
De Kalb	1.5	350e	549b
Iowa:			
Bremen	3.5	18,590e	27.9
Calhoun	....	....	93.5
Cherokee	8.7	8,226e	47.4
Chickasaw	10.25	10,028e	34.25
Decatur	....	....	32.4
Delaware	2	5,000e	....
Emmet	27b	40,889e	27
Fremont	....	....	40
Howard	5.0	17,000e	....
Jones	10	50,000e	35
Kossuth	60	110,000e	150
Lee	2	44,000d	....
Lyon	1.15	1,500e	14.1
Marion	6.5	70,000d	60.4
Marshall	23	49,000e	....
Monona	8	12,329e	8
Muscatine	12.0	41,459e	78.4
Palo Alto	....	....	200
Pottawattamie	....	....	70
Scott	....	....	30
Union	3.9	65,000d	28.5
Kansas:			
Anderson	17	1,500ce	40
Barton	105	....	230
Crawford	8	6,000d	8
Hamilton	10	3,000d	78
Haskell	70	4,500e	70
Hodgeman	25	2,743f	573
Jackson	10.3	86,000d	20.0
Miami	14	70,000d	....
Pawnee	90	1,800	1,670
Riley	20	....	....
Rooks	204	20,140d	....
Sedgwick	65	33,640e	336
Maryland:			
Kent	2	30,000d	40
Michigan:			
Houghton	....	....	33
Isabella	3	3,200e	....
Leelanau	3.86	4,992e	10
Oscoda	....	....	5
Minnesota:			
Beltrami	4	6,000d	....
Benton	16	30,000d	105
Blue Earth	25.1	66,000e	....
Brown	16	26,180e	19
Carlton	82	480,000d	465
Chippewa	22	49,994e	....
Cottonwood	15	60,000f	130
Dakota	....	....	35
Dodge	10.75	40,913f	....
Faribault	19.2	34,385d	449
Grant	11	30,000	100
Goodhue	3	43,623	....
Houston	8.4	13,200e	26.9
Hubbard	....	....	4.0
Jackson	19	89,347d	122
Lake	8	30,184d	300
Lincoln	3.5	7,755e	26.8
Marshall	....	....	52
Mahnomen	4	15,200	57
Martin	9.5	....	....
Mower	....	....	900
Nobles	12	37,146d	24
Olmsted	8	28,041e	8
Otter Tail	35	98,000d	37.3
Pennington	23	19,682e	....
Pine	10	30,000e	89
Pipestone	7.1	35,500f	7.1
Redwood	5.5	12,300e	....
Rice	18.5	116,828d	33.1
Rock	9.8	9,461	14.8
Roseau	5	7,459e	38.7
Sherburne	6.75	12,742e	....
Sibley	41.6	76,873d	106.5
Stearns	25	62,000d	500
Steele	9	35,044d	....
Stevens	5.5	26,146d	117.6
Watonwan	20	38,000d	26.5
Mississippi:			
Lafayette	4	8,500e	350
Stone	....	....	260
Missouri:			
Audrain	200	....	....
Cole	200	....	....
Holt	....	15,000	....
Marion	150	12,000e	....
Mississippi	60	3,000d	250
Monroe	20	80,000d	300
Newton	50	300e	50
Scott	....	....	400
Washington	....	....	200
Montana:			
Chouteau	200	3,000e	800
Gallatin	34.0	28,850e	961
Golden Valley	55	1,925d	520
Hill	500	50ce	500
Lake	20	4,000d	200
Nebraska:			
Sarpy	40	25,000e	400
White Pine	13	1,300e	170
Nevada:			
Eureka	60	....	....
North Carolina:			
Chatham	30	....	100
North Dakota:			
McLean	....	....	30
Mountrail	20	54,000d	120
Williams	93	39,660e	628
Ohio:			
Cuyahoga	8.3	46,489e	42.0
Medina	15	7,000d	20.0
Morgan	4	58,000e	4
Muskingum	10	6,000d	7
Williams	9	....	....
Wood	....	....	486
Oklahoma:			
Craig	48	21,000	198
Tillman	50	200ce	313
Oregon:			
Douglas	10	....	304
Linn	5	4,000d	....
Washington	1.0	4,838d	1.0
South Dakota:			
Buffalo	28	22,000e	135
Faulk	40	800cd	....
Haakon	30	60,000d	450
Hutchinson	49	66,000e	....
McCook	18	6,163e	....
Pennington	69	....	396
Roberts	20	3,000e	100
Texas:			
Denton	420	64,000d	....
Gonzales	19	92,000d	19
Jim Hogg	10	25,000d	....
Matagorda	10	5,000d	500
Maverick	24.1	91,000d	102
Navarro	150	45,000d	500
Parmer	50	50ce	400
Red River	....	....	25
Walker	.60	150,000	250
Williamson	21.6	210,000d	....
Wilson	....	....	1,000
Washington:			
Franklin	3	3,300e	15
Skagit	2.5	....	....
Skamania	4.0	16,000e	250
Thurston	10	3,000e	200
Whitman	10	2,500e	3,200
West Virginia:			
Gilmer	6	120,000e	30
Wisconsin:			
Ashland	20	800ce	....
Bayfield	21.5	26,343e	106
Dane	99.2	211,625d	....
Douglas	17.7	26,289e	....
Wyoming:			
Campbell	18.0	25,631	292.2d

a—Town. b—Called township roads. c—Per mile. d—Cost includes bridges. e—Cost does not include bridges f—Includes culverts.

Dirt Road Maintenance

County	Kind of soil	Average width of graded sections feet	Average crown inches	Mileage kept in condition	Equipment used in keeping surface even	Frequency of treating a given stretch of road	Percentage of time road has firm smooth surface	Other treatment received by earth roads
Arkansas:								
Conway	Clay, gravelly sand, gumbo	16	....	100	Drags and scrapers	After each rain	75	Grading when necessary
California:								
Fresno	All kinds	15	3	4,000	Graders and drags; caterpillar & truck power	Every 2 years	75	Oiling
Plumas	Various	16	3	200	Drags and scrapers	4 times a year	16*	....
Colorado:								
Otero	Clay and gumbo	30	3	600	Drags, graders, scrapers, maintainers	As weather permits	....	None
Routt	Clay, sand, sand-clay	16	4	800	Drags and graders	Depends on weather	....	....
Saguache	Clay, sand and gravel	20	....	....	Drags, graders, scrapers, dredges	In spring & periodically	75	None
Florida:								
Bradford	Sand	42	6	130	Three-way drags	Twice a month	50	Road machine
Charlotte	Sand	20	6	25	Graders, blade & tractor	Every 6 months	1	Marl-surfaced roads dragged after every rain
Flagler	Sand	40	None	10	....	Weekly	50	None
Georgia:								
Spalding	Clay	20	12	100	Drags, scraper, tractors teams	Monthly	75	Heavy machining yearly
Idaho:								
Idaho	Gumbo	16	12	500	Drags on county roads, blade graders on state	Continuous on state; after rains on county	50	None
Twin Falls	Portneuf loam, volcanic ash loam	25	....	31	Drags	2 to 6 times after spring rains	25	None
Illinois:								
Carroll	Clay, sand	30	12	120	Drags, 2-horse graders	2 days a week summer & fall	70	Oil 10 miles
Cass	All kinds	28	8	75	Drags	After each wet spell	90	Oil
Champaign	Black gumbo	24	10	900	Blades and tractors	Once a week	67	All are oiled
Douglas	Clay and gumbo	26	7	406	Drags & maintainers	Weather controls	90	Oil
Greene	Clay, sand, loam	24	....	110	Drags	Weekly	83	Grading
Henderson	....	24	12	200	Drags & patrol graders	Twice a week	Bet. rains	Oil 50 miles
Jasper	Clay, loam and sandy	24	8 to 12	200	Drags	Once in 2 weeks	....	None
Johnson	....	16	8	80	Drags & graders	After rains & freezes	90	None
Kane	....	30	6	500	Small graders and drags	Twice a week (county roads)	80	None
McDonough	Clay, sand and gumbo	24	6	220	Maintainers	Twice a week	....	Oil
McHenry	Clay	28	6	500	Drags & scrapers	Generally 3 times a month	83	200 mi. patrolled by contract; patch with gravel
Macoupin	Clay, gumbo, loam	24	10	260	Planers & drags	Weekly	....	Oil 80 miles
Menard	Clay, sand, gumbo	28	6	....	Drags, scrapers, small patrol graders	Once a week	80	Oil state-aid and some secondary
Pulaski	Clay, gumbo	24	....	18	Drags & scrapers	Once in 2 weeks	80	Clean ditches occasionally
Richland	....	25	6	100	Graders, patrol, drags	After each rain if needed	83	Oil 2 miles
Sangamon	All kinds	20	9	800	Drags & blade maintainers	Weekly, after rains	75	Oil; then good 95 per cent of time
Wabash	Yellow clay, sandy clay	16-20	6	Small	Drags & graders	None to twice a month	10	None
White	Sand & clay	30	12	150	Drag or light grader	Once a week	95	....
Whiteside	....	20	8	166	....	9 months of the year	....	Oiled 24 miles
Williamson	Clay & gumbo	15	6	800	Graders & drags	65 times a year	80	....
Woodford	Clay, sand & gumbo	24	12	150	Drags & maintainers	40 to 50 times a year	70	Oil some
Indiana:								
De Kalb	Clay & sand	....	....	350	Drags & light maintainers	Twice a week, county roads	20	....
Kosciusko	All kinds	....	....	....	Drags, graders & maintainers	Once or twice a week	....	Resurface with gravel
Putnam	Clay	18	....	Few	....	....	....	....
Iowa:								
Bremer	Clay, sand, sandy clay & gumbo	28	6	16	Patrol graders	Daily	90	....

Dirt Road Maintenance (Continued)

County	Kind of soil	Average width of graded sections feet	Average crown inches	Mileage kept in condition	Equipment used in keeping surface even	Frequency of treating a given stretch of road	Percentage of time road has firm smooth surface	Other treatment received by earth roads
Iowa (Continued)								
Calhoun	Clay & gumbo	24	6	24	Patrol maintainers	Every 3 days	85	None
Cherokee	Sandy loam & gumbo	26	Flat	111.5	Drags, patrol graders	Graders daily, drags when needed	85	Use gravel
Chickasaw	Clay, gumbo	24	....	34.2	Graders	Twice a week	90	Heavy grader work
Davis	....	26	6	185	Crawler tractors, graders, 1-man maintainers, drags	After each rain	70	None
Decatur	Clay & loam	24	6	125	Drags	....	....	....
Delaware	Clay & sand clay	24	6	....	Small graders, power maintainer	After each rain; oftener where traffic is heavy	....	....
Des Moines	All kinds	26	6 to 8	700	Drags, one-man maintainer, patrol graders, heavy graders	....	....	None
Dickinson	Clay	24	6	280	Drags	Every 2 weeks	....	None
Dubuque	Clay	27	....	60	Drags, patrol graders, maintainers	100 days a year	70	None
Emmet	Sandy loam, gumbo & clay	24	12	22	Drags & 2-horse patrol graders	After each rain	75	None
Fayette	Clay & gumbo	22	6	57	Drags, small patrol graders, 1-man maintainer	3 times a week	75	....
Fremont	Gumbo	28	None	40	Horse patrols	....	75	None
Howard	Clay	28	4	83	Patrol grader & tractor graders	Nearly every day	....	....
Jones	Clay	....	....	....	....	Twice a week	75	None
Kossuth	Gumbo	26	6	150	Blade graders	Twice a week	75	None
Lee	Clay	....	....	26	Drags & blade graders	Twice a week	None	None
Lyon	Clay	26	Flat	13	Wood drags pulled by tractors	....	70	None
Marion	Clay, gumbo	24	6	60	Drags & blade graders	5 times a month	30	None
Marshall	Clay, loam	....	8	106	Drags & blade graders	Twice a week	Until rain	....
Mills	Clay gumbo	26	6	135	Maintainers, graders, drags	....	Till next rain	None
Monona	Clay and gumbo	26	6	98	Drags and patrol blades	Twice a week	....	None
Muscatine	Gumbo, sand, clay, silt loam	26 & 28	6	156	Patrol graders, 5-ton caterpillars, blades, surface grader, maintainers, trucks	75 times a year	60	None
Palo Alto	Gumbo	26	....	200	Drags and scrapers	Once a week	75	....
Pottawattamie	Sandy clay	26	None	450	Maintainers, caterpillar tractors, graders	Continuous	95	None
Scott	....	26	6	500	Drags, harrows, maintainers, graders	....	....	....
Taylor	Clay	25	....	135	Patrol graders	Twice a week	75	Heavy graders occasionally
Union	Clay	26	Flat	155	Patrol graders	Twice a week	90	....
Woodbury	Loess, clay, gumbo	28	6	...	Blades, tractors	Twice a week	Until rain	None
Kansas:								
Anderson	Gumbo	28	....	130	Patrol graders	At work all the time	90	....
Barton	Gumbo and sand clay	26-30	...	230	Drags, small graders	40 times a year	75	Sand
Crawford	Sandy clay and gumbo	28	3	8	Drags, grad., slips, mowers	1 to 3 times a week	98	Harrow and roll
Hamilton	Loam	24	....	60	Drags	Once a month	100	Small graders
Harvey	Clay	...	8	103	Patrol graders	....	....	....
Haskell	....	28	....	70	Patrol graders, Fresno	Full time patrol	90	None
Hodgeman	Clay and gumbo	24	5	....	Drags, heavy graders with caterpillars	Once in 20 days	50	Clean ditches with heavy equipment; clear weeds and snow
Jackson	Clay and sand-clay	26	5	180	Patrol graders, drags, road harrows	Continuous patrol	97	None
Miami	Clay and gumbo	28	4	....	Patrol graders	....	75	....
Pawnee	....	22	10	800	Horse and truck patrol; long wooden floats	Once a week	90	Light grading
Riley	....	30	6	180	Patrol graders, drags, scrapers, maintainers	Patrol 80 miles a day, drag 100 miles	80	Large grader
Rooks	Clay and sand	25	8	200	Drags and patrol graders	Once a week	75	None
Sedgwick	....	28	5	336	Drags, maintainers, graders, tractors, trucks	After each rain	90	....
Maryland:								
Kent	Sandy clay	20	7½	475	Scrapers, graders, roller, tractors	Constantly when weather permits	75	None
Michigan:								
Dickinson	Clay and sand	30	12	13.5	Drags	Twice a week	....	Calcium chloride
Houghton	....	20	6	33	Patrol grader & truck blade	Once a week	75	None

Leelanau	Sandy loam, clay	20	3	32	Heavy graders & tractors, team grader patrols, 1-man power graders	Twice a week	....	None
Oscoda	....	12	12	....	Truck with scraper, maintainers, drag	Continuous on gravel, after each rain on dirt	Most	....
Wexford	Sand	...	....	....	Scrapers on trucks and graders	Constantly in summer	....	....
Minnesota:								
Beltrami	Clay, sand and gumbo	20	6	255	Drags and patrol graders	3 or 4 days a week	75	None
Benton	Sandy clay and clay	40	....	30	Drags and patrol graders	3 times a week	75	Gravelling
Blue Earth	Clay	24	6	....	Planers and patrol graders	3 times a week	100	....
Brown	....	24	None	19	Patrol graders	Twice a week	90	None
Carlton	Sand clay	22	3½	234	Patrol graders	Once a week	75	Regrading
Cass	....	24	5	184	Drags, patrol graders	....	90	....
Chippewa	Clay and gumbo	18	6	700	Horse patrol graders	....	20	Gravelling
Cottonwood	....	24	6	30	Drag and patrol graders	Twice a week—once if dry	....	....
Dodge	Black loam	...	....	23	Drags and blade graders	40 times a year	60	....
Faribault	Clay and gumbo	22	6	900	Drags and patrol graders	Once or twice a week	....	....
Goodhue	Clay	...	....	....	Small graders	....	....	....
Grant	Gumbo	24	Flat	140	Drags and graders	....	....	None
Houston	Clay and sand	24	6	109	Drags, patrol graders, heavy blade graders	3 days a week	75	....
Hubbard	Sand and clay	...	....	....	Drags and patrol graders	....	90	....
Jackson	Sandy clay	36	....	19	Patrol graders	Daily, March 1 to Dec. 1	Till next rain	Heavy blading
Lake	Clay	24	12	137	Motor patrol with trucks and graders	April 1 to Dec. 1	95	Graveling
Lincoln	Clay and loam	24	....	....	Fresno, grader, tractor small maintenance graders	Continually	100	....
McLeod	Clay	40	...	230	Power grader, drags	Once or twice a week	95	....
Marshall	Gumbo and clay	24	10	40	2-horse and 4-horse graders	Once or twice a week	100	Occasional planing
Martin	Black loam and gumbo	24	6	65	Drags	Eight times a month	80-95	Occasional light reshaping
Mower	Loam, clay	20	6	....	2-horse patrol graders	Daily	....	....
Nobles	Clay and loam	24	4	24	Drags	3 times a week	100	None
Olmstead	Clay, sand, loam, rock	24	6	85	Drags and patrol graders	Twice a week	50	None
Otter Tail	Clay and sandy clay	22-24	...	156	Drags, graders & planers	After each rain	75	None
Pennington	Gumbo and clay	26	....	118	Maintenance graders	Daily	95	None
Pine	All kinds	24	....	217	2-horse grader and power patrol units	....	....	....
Pipestone	Clay, sand clay, sand loam	18-20	12	400	Drags, patrol graders	After rains	30	....
Redwood	Clay	24	....	12	Patrol graders	Twice a week	90	....
Rice	Clay and sand	33	...	257	Patrol graders and drags	Twice a week	90	None
Rock	....	24	2½	14.8	Patrol graders	....	....	....
Roseau	....	24	5	126	Drags, planers, graders	After every rain	....	None
Sherburne	Sand	20-24	...	26	2-horse patrol graders	2 or 3 times a week	75	....
Sibley	Clay and gumbo	24	....	116	Graders	3 or 4 times a week	98	....
Stearns	Clay and sand	24	....	235	Graders	2 or 3 times a week	90	None
Steele	Clay	24	2½	9	Drag	Twice a week	90	....
Stevens	Sand and gumbo	24	3	100.1	Drags and blade graders	....	....	....
Washington	Clay, sand & sandy clay	....	....	107	16 patrol graders, 1 power maintenance machine	Twice a week	....	....
Watonwan	Sandy clay to heavy black soil	24	6	26.5	Drags	Twice a week	....	None
Wilkin	Gumbo, sandy loam	24	6	68.9	Patrol graders	3 or 4 times a week	80	....
Mississippi:								
Jefferson	Sandy clay	18	....	550	Road machines	3 times a year	50	None
Jones	Clay and sand	14-24	....	650	....	....	Until it rains	....
Lafayette	Clay	22	....	500	Drags, road machines, tractors and teams	Dragged every 2 weeks	80	Machined every 6 months
Stone	Sandy clay	22	....	315	Road machine	After each rain	90	Constant repairs
Missouri:								
Audrain	....	24	6	....	Drags	....	....	....
Cole	....	....	8	50	Blade drags	Once or twice a month	75	....
Holt	....	20	....	450	Drags, multiplate-blade maintainers	Every 10 days	90	....
Marion	Clay and gumbo	22	....	125	Drags and patrol grader	Twice a week	75	....
Mississippi	Gumbo and sand	24	....	150	Drags and scrapers	Twice a month	50	None
Newton	Clay and rock	24	....	75	Patrol graders	After each rain	....	....
Pulaski	Clay and gravel	18	....	200	Scrapers, drags, 2-horse patrol graders, power graders	2 or 3 times a season	50	Gravel muddy stretches
Putnam	Clay	40	....	50	Drags, graders, tractors	Continuous	Almost all	None
Scott	Clay, sand and gumbo	18	....	400	Drags, scrapers and light graders	Clay and gumbo dragged after each rain	75	Graded twice a year & sand graded every year or two
Washington	....	....	....	100	Steel 3-way drags	Depends on rain	50	....
Montana:								
Beaverhead	All kinds—solid rock to alkali gumbo	16	12	350	3-way drags, 1-section drags, graders	Continuous	Bet. wet spells	None
Choteau	Gumbo, clay, sand	30	....	600	Drags and graders	According to rain, monthly	90	None
Gallatin	Clay, gravel, loam, a little gumbo	20	6	800	Wood drags, steel drags, blade graders	See foot note†	....	Reshape in spring with heavy grader where necessary

Dirt Road Maintenance (Continued)

County	Kind of soil	Average width of graded sections feet	Average crown inches	Mileage kept in condition	Equipment used in keeping surface even	Frequency of treating a given stretch of road	Percentage of time road has firm smooth surface	Other treatment received by earth roads
Montana (Continued)								
Golden Valley	Clay, sand, gumbo	20	6	....	Drags; graders occasionally	10 times a year	95	....
Hill	Clay, gumbo, sandy	....	18	500	Drags, graders, road finishing machines	After each rain	80	None
Lake	Gravel, loam, clay, sandy clay, sand	20	8	40	Drags, light graders, levelers, scrapers	After rains—about 6	50	....
Nebraska:								
Butler	Clay, sandy gumbo	20	....	700	Drags and maintainers	After each rain	90	None
Loup	Sandy clay	24	6	11	Blade and tractor	Twice a week	95	None
Sarpy	Clay and gumbo	....	....	200	Heavy tractor & teams, graders	Main roads daily, others weekly	Main 100	None
Nevada:								
Eureka	....	18	....	100	Grader and drag	2 or 3 times a year	....	....
White Pine	Loam, gravel, alkali, clay	14	4	700	Graders and drags	F. A. every 10 days; county twice a season	80-90	None
North Carolina:								
Henderson	Rotten rock	18-30	....	18	Drags	Not much system	....	....
Washington	Sand and clay	18-25	....	250	Drags and maintainers	Once a week	....	None
North Dakota:								
McLean	Clay and sandy clay	30	....	693	Drags, patrol graders and trucks	....	75	None
Mountrail	Clay and sandy clay	24	6-8	100	Drags and small blade maintainers	....	75	None
Williams	....	24	....	628	Drags and patrol graders	4 times a month	90	None
Ohio:								
Brown	Clay	16	6	100	Road maintainers, scrapers, drags	Once a month	10	None
Cuyahoga	Clay	24	9	80	....	Once a month	50	Dress with slag or cinders
Darke	Clay	....	....	....	Drags and scrapers	Every other day	....	....
Holmes	....	....	....	35	Drags and maintainer	Weekly in suitable weather	....	....
Jefferson	Clay, sand, sandy clay	10	4	600	Drags, tractors & graders	Twice a year	33	None
Logan	Clay	....	....	....	Drags and graders	3 or 4 times each spring	60	....
Medina	Clay	24	12	40	Drags and graders	Once a week	50	....
Muskingum	Clay, sand, sandy clay, fire clay	....	12	25	Drags & road maintainers	Twice a week	99	....
Wood	Clay, some sand	20	6	486	Drags	4 to 8 times a year	50	None
Oklahoma:								
Craig	Sandy clay	30	....	75	Maintenance graders	Weekly, oftener if needed	90	....
Le Flore	....	....	....	....	Scrapers, horse patrols, blades, trucks	Every 3 days	....	....
Tillman	Sand, sandy clay	28	6	313	Drags, patrols, maintainers	45 times a year	96	....
Oregon:								
Douglas	Every known soil	20	12	1,000	Graders drawn by horses and trucks, drags	8 to 15 times a year	50	None
Lincoln	Sandy loam	12	6	....	Occasional use of tractor & blade in summer	....	....	....
Yamhill	Mostly clay	20	12	300	Drags, 3-horse graders	Spring and fall	75	....
Pennsylvania:								
Erie	Gravel, clay, sandy	16	4-6	1,355	Drags and scraper	....	75	....
South Carolina:								
Greenwood	Clay	30	12	130	Drags and road machines, tractors and trucks	Once a week	95	....
South Dakota:								
Buffalo	Gumbo	22	6	125	Maintainers and small graders	Varies with weather; about every 10 days	85	None
Faulk	....	24	....	288	25 drags, 10 maintainers	After rains	75	Blade in the spring
Haakon	Sand, gumbo	24	6	450	Drags, blade, patrol	Twice a week	90	....
Hutchinson	Mostly clay	24	4	100	Drags, patrol, blades	After each rain	50	None
McCook	....	20	3	231	Drags, road fixer, blades	Twice a month	98	....
Pennington	Clay, sand, sandy clay, gumbo, solid rock, shale	22-24	4	437	Drags, patrol graders	12 times a month	90	....
Roberts	Mostly clay	24	....	300	Light patrol graders	Every 3 days	75	None
Spink	All kinds	24	....	400	Drags, patrols, graders, power finishers	....	....	....
Texas:								
Bee and Brooks	Clay, sand, gumbo	18	....	200	Tractors, graders, maintainers, drags	After rains	80	None
Denton	Clay and sand Black	20 18	....	1,500 2,600	Drags Drags, scrapers, blades, tractors, trucks	12 times a year	90 75	None ....

					...graders, maintainers, drags	After rains	80	None
Denton	Clay and sand	20	....	1,500	Drags	12 times a year	90	None
Ellis	Black	18	....	2,500	Drags, scrapers, blades, tractors, trucks	....	75	....
Gonzales	Mixed	20	....	400	Graders hauled by 5 tractors and 6 teams	After each rain	Until rain	None
Jim Hogg	Sand	20	....	13	Scraper	Every 90 days	....	None
Matagorda	....	24	....	400	Drags	Once a month	Until rains	....
Maverick	Sandy clay and gumbo	24-26	....	90	1-man maintainers, drags	After each rain	75	None
Navarro	Gumbo mostly, some sand	30	10	500	Drags and graders	After each rain	Until next rain	None
Parmer	Sandy loam	24	....	400	Drags, blade graders, tractor	Depends on moisture	90	None
Red River	Sand and sandy clay	28	....	25	Drags, scrapers & graders	After each rain	50	None
Taylor	Sand and gumbo	24	....	1,340	Drags, graders, scarifiers, etc.	Every 2 weeks	....	....
Walker	Clay and sand	34	24	300	Scrapers	Every 2 weeks	85	None
Wilson	Sand and clay	20	....	400	Drags and blade graders	After each rain	40	....
Washington:								
Adams	Light volcanic ash	20	8	150	Drags and graders	3 or 4 times a year	70	None
Clallam	All kinds	20	4	800	Drags and graders	1 to 4 days	....	....
Ferry	....	....	....	300	Grader	Spring and fall	25	....
Thurston	Clay and sand	16	....	200	Graders	30 days	....	None
Franklin	Sand	22	....	450	Light graders	After rains and in winter	60	Strawing
Lincoln	Sand and clay	22	12	1,000	Drags and graders	After each rain	50	None
Skamania	Sandy soil, some gumbo	16	4	100	Power graders	Once a week	....	None
Whitman	....	16	4	2,000	Steel drags, graders	3 times a year	....	....
West Virginia:								
Gilmer	Clay	26	16	30	Drags, 1-man graders	Main roads after rains	75	Heavy grader on all in spring
Mineral	Shale and sandy clay	28	10	100	Light & heavy graders with tractors, steel drags	State roads every 2 weeks county roads every 2 mos.	90	Asphaltic oil
Wisconsin:								
Ashland	Clay, sand, sandy clay	24	6	165	Drags and graders	Daily	90	None
Bayfield	Sand and clay	24	6	155	Graders	4 times a week	90	Ditch cleaning
Douglas	....	24	....	200	Patrol graders	Daily	....	....
Jefferson	Clay	26	4	275	Small graders	Daily	....	....
Waushara	Sand and clay	22	4	150	Patrol graders and drags	....	70	Ditching and draining
Wyoming:								
Campbell	Clay and sandy clay	20	10	126	....	......	....	....
Sheridan	Sandy clay, gumbo	24	6	750	Drags	4 times a year	75	None

* For three months all roads are covered with 3 to 16 feet of snow. † In spring, whenever roads start to dry out after rains; in summer, after occasional showers providing enough moisture.

County Highway Work in 1925

(*Continued from page* 137)

have a firm, smooth surface?" "What other treatment do any of your earth roads receive?"

Several states are not represented in these tables because the counties of these states have little or nothing to do with road construction or maintenance. The conditions in Pennsylvania and Connecticut are explained in the following statements, prepared from information furnished by the state highway authorities.

PENNSYLVANIA TOWNSHIP ROADS

The larger part of the mileage of the public highways in Pennsylvania is under the direct supervision and direction of township supervisors. There are 1,513 townships of the second class and approximately 79,200 miles of township roads. With a few exceptions, these townships employ no engineers in connection with their road improvement, but such engineering services as are rendered are donated by the state department of highways.

Under such condition, it would seem quite probable that the maintenance of these township roads leaves much to be desired in the way of effectiveness of results and economy of operation.

Probably a very large percentage of the dirt or natural-soil roads of the country are under similarly inefficient supervision and it can hardly be expected that the character of these roads will be greatly improved until something is done in the various states to place them more directly under expert guidance whereby advantage can be taken of wide experience and scientific knowledge similar to that brought to bear on the construction and maintenance of the more expensive road surfaces.

TOWN HIGHWAYS IN CONNECTICUT

In the state of Connecticut, the counties have nothing whatever to do with the highways except to see that the towns or cities within the county keep in proper condition the roads within their limits. In case a town or city refuses to do so, petitions may be brought before the county commissioners and they can order the road put and kept in condition.

Outside of the state highways, the maintenance of roads is vested in either the boards of selectmen or the superintendents of streets or some similar official.

Bituminous Concrete Laid in 1925

County	Miles constructed during 1925	Cost	Miles in county at end of 1925	Average width of improved surface, feet
California:				
Fresno	...	....	147	16
Idaho:				
Twin Falls	...	....	11.75	..
Michigan:				
Calhoun	...	....	2½	..
Dickinson	...	....	2	..
Houghton	...	....	0.5	16
Nebraska:				
Sarpy	0.02	$724a	....	20
Ohio:				
Cuyahoga	1.79	178,216a	17.07	18
Wood	...	....	33	..
Texas:				
Williamson	10.43	161,000c	10.43	..
Wilson	45	....	45	18

a—Includes grading. b—Includes bridges. c—Includes grading and bridges

Road Maintenance

County	Kind of Road	Amount Spent	Miles Maint'd
California:			
Fresno	Graded	$33,000	134.5
	Oiled gravel	60,000	66.8
	Bit. concrete	6,000	147.1
	Warrenite-bit.	5,000	72.2
Plumas	Graded	90,000	400
Florida:			
Bradford	Graded	10,000	130
Charlotte	Graded	15,000	50
	Marl	60,000	100
Sarasota	Sheet asphalt	2,650	25
Idaho:			
Idaho	Graded	10,000	500
	Macadam	20,000	90
Twin Falls	Graded, sand-clay, gravel, macadam, bit., macadam, bit. concrete	9,462	350
Illinois:			
Carroll	Graded	5,000	34
	Gravel	2,500	12
	Macadam	900	8
	Cem't. concrete	4,000	17
Champaign	Graded & oiled	250.000	885
Douglas	Graded	70.000	405
	Macadam	5,500	38
	Cemt. concrete	400	5.1
	Brick	100	12.7
	Oiled earth	85,000	310
Jasper	Cemt. concrete	15,000	165
McDonough	Graded	10,000	220
Pulaski	Graded	27,500	365
Wabash	Gravel	20,000	200
White	Graded	......	900
Williamson	Gravel	800	2
	Bit. macadam	1,200	3
	Cemt. concrete	8,000	43
Woodford	Graded	15,479*	80
Indiana:			
Hancock	Gravel	85,000	483
Jay	Gravel	74,000	470
Iowa:			
Bremer	Graded	9,735	16.1
	Gravel	1,416	11.7
Calhoun	Graded	1,764	93.5
	Gravel	14,292	221
Cherokee	Graded	9,413	111.5
	Gravel	902	4.2
Chickasaw	Graded	2,237	72
	Gravel	1,120	31.5
Delaware	Graded	16.000	110
	Gravel	5.000	40
Des Moines	Gravel	6,000	7
Dubuque	Gravel	25,000	..
Emmet	Graded	2,000	22
	Gravel	39,526	172.5
Fayette	Gravel	68,900	155.6
Fremont	Graded & ungraded	15,000	187
Grundy	Ungraded	4,000	950
Howard	Ungraded	10,000	75
	Graded	10,000	8
	Gravel	20.000	45.5
Jones	Ungraded	20,000	145
	Graded	17,000	35
	Gravel	10,000	15
	Macadam	2,000	2
Kossuth	Ungraded	50,000	1,346
	Graded	30,000	150
	Gravel	60,000	450
	Cement conc.	1,800	13
Lyon	Ungraded & graded	3,228	108.9
Marion	Ungraded	34,047	105
	Graded	35,000	92
Marshall	Ungraded	14,000	106
	Graded	200	2
	Gravel	31,000	60
	Cement conc.	1,800	22
Mills	Ungraded	24.000	86
	Graded	25.000	49
Monona	Ungraded & graded	18,207	98
Muscatine	Ungraded, graded sand clay, gravel concrete	51,312	151.5
Palo Alto	Ungraded	39.000	800
	Graded	10,000	100
	Gravel	30.000	157
	Cement conc.	1,100	11
Pottawattamie	Cement conc.	100	0.75
Scott	Ungraded	56,000	500
	Graded	20,000	30
	Gravel	16,000	40
	Cement conc.	28,000	57
Taylor	Ungraded	22,095	135
Union	Graded	19,000	55
Kansas:			
Anderson	Graded	8,000	120
	Gravel	10,000	31
Hamilton	Graded	1,200	78
	Sand-clay	600	6
Harvey	Sand-clay	24,301	175
Haskell	Graded	5,400	70
Hodgeman	Ungraded	229	44
	Graded	3,472	244
Jackson	Ungraded	14,308	170
	Graded	11,000	30
	Gravel	60	1.5
Miami	Ungraded	30,000	150
Kansas (Continued)			
Rooks	Graded	21,900	102
Sedgwick	Ungraded	95,000	1,100
	Graded	63,360	336
	Sand-clay	6,450	20
	Cement conc.	8,309	37.5
	Brick	4,155	23.5
Maryland:			
Kent	Ungraded	15,000	500
	Graded	10,000	40
	Top-soil	3,000	400
	Sand-clay	3,000	75
	Gravel	200	10
	Macadam	3,000	25
	Cement conc.	3,000	15
Michigan:			
Branch	Gravel	35,000	250
	Cement conc.	15,000	30
Calhoun	Gravel	119,828	435
	Cement conc.	8,295	40
Houghton	Graded	8,162	33
	Sand-clay	13,320	54
	Gravel	3,067	13.2
	Macadam	11.355	14.4
	Bit. macadam	6,661	33.3
	Bit. concrete	241	0.5
	Cement conc.	30	80.8
Isabella	Gravel	42.000	400
Keweenaw	Sand-clay	3.950	26
	Gravel	3,000	10
	Macadam	15,880	18
	Bit. macadam	1,160	2.5
	Cement conc	560	1.3
Leelanau	Ungraded, graded and gravel	31,874	218
Ogemaw	Gravel	20,725	103
Minnesota:			
Beltrami	Graded	8,379	180
Benton	Graded	10,000	120
Blue Earth	Graded & gravel	40,510	194.5
Brown	Graded & gravel	17.808	137.9
Carlton	Graded	11,710	234
	Gravel	60,000	219
Cass	Ungraded, gravel and sand-clay	14,500	183.9
Chippewa	Graded	13,329	111
Cottonwood	Graded	15,000	130
Dakota	Gravel	33,200	225
Dodge	Ungraded	1,429	23.1
	Gravel	13,381	70.9
Faribault	Graded	61,188	99.2
	Gravel	80,594	286
Goodhue	Gravel	55,851	164
Grant	Graded	8,000	125
Houston	Graded	19,670	109.4
Hubbard	Gravel	10,000	79.1
Jackson	Graded	22,702	122
Lake	Graded	20,000	184
Lincoln	Graded	3,876	33.8
	Gravel	9,947	94.1
McLeod	Gravel	20.882	230.1
Mahnomen	Graded	6,300	70
Mower	Gravel	29,515	154.4
Nobles	Graded	2,275	24
	Gravel	33,778	183.4
Otter Tail	Ungraded, graded sand-clay & gravel	46,500	354.4
Pennington	Ungraded	5,054	24.5
	Graded	3,507	17
	Gravel	16.915	82
Pine	Graded & gravel	25.000	217
Pipestone	Graded	1,500	7.1
	Gravel	16,500	91.4
Redwood	Gravel	46,417	207
Rice	Ungraded, graded, gravel & cement, concrete	30,346	521
Rock	Graded	584	14.8
	Gravel	18.390	99.3
Roseau	Ungraded	10,183	147.3
Sherburne	Graded	6,961	85.6
Sibley	Ungraded	11,023	102
	Graded	1,363	14
	Gravel	48,966	603
Stearns	Graded	23,000	235
Stevens	Graded	13,797	100.1
Swift	Ungraded	900	55
	Gravel	8.500	106.5
Washington	Gravel	22.000	107
Watonwan	Gravel	16,547	120
Wilkin	Ungraded	16,781	92.3
Mississippi:			
Jones	Gravel	6,000	60
Missouri:			
Holt	Ungraded	25.000	600
Marion	Gravel	6,000	215
Monroe	Graded	15,000	500
Newton	Graded	1,000	75
Pulaski	Graded	6,000	200
Scott	Graded, gravel & cement conc.	37,000	550
St. Clair	Graded	15,000	65
Washington	Ungraded	15,000	300
Montana:			
Beaverhead	Gravel	60,000	350
Gallatin	Graded	47,180	961.5
	Gravel	6,150	111.5
	Macadam	200	5.5
	Bit. macadam	300	5.5
	Cement conc.	150	3.8
Golden Valley	Graded	18,185	300
Hill	Graded	10,000	500

Montana (Continued)			
Lake	Ungraded	13,000	800
	Graded	3,000	200
	Top soil	13,000	960
	Gravel	3,000	40
Nebraska:			
Butler	Ungraded	35,000	700
Sarpy	Graded & gravel	25,000	425
Nevada:			
Eureka	Ungraded	3,000	200
White Pine	Ungraded, graded, top soil & gravel	10,000	1,000
North Carolina:			
Washington	Graded	15,000	250
North Dakota:			
McLean	Graded	1,030	30
	Top soil	10,726	693
Mountrail	Graded	5,200	100
Williams	Graded	21,332	628
Ohio:			
Cuyahoga	Gravel	23	3.2
	Macadam	2.331	10.7
	Bit. macadam	43,860	22.4
	Sheet asphalt	3.020	6.9
	Cement conc.	13.651	84
	Brick	358.128	277
	Travel-bound mac.	1,072	4.7
Darke	Gravel	55.000	100
Logan	Bit. macadam	4,000	18
	Cement conc.	3.500	35
Morgan	Gravel	15.000	41
	Macadam	12.500	36
Preble	Gravel	35,000	150
Oklahoma:			
Craig	Graded	8.000	149
LeFlore	Graded	58,140	130
Tillman	Graded	70,000	210
Oregon:			
Douglas	Gravel	70,000	1,000
Lincoln	Gravel	2,500	15
Linn	Gravel	40,000	1,000
Washington	Macadam	3,500	28
South Carolina:			
Greenwood	Top soil	47,000	130
	Cement conc.	1,000	3.2
South Dakota:			
Buffalo	Graded	4,750	100
Faulk	Graded	20,339	67.8
Haakon	Graded	12.000	420
Hutchinson	Ungraded	15,000	80
McCook	Graded	2.200	231
Pennington	Ungraded	33,709	461
Roberts	Graded	19,539	400
Texas:			
Bee & Brooks	Gravel	25,000	44
Denton	Gravel	124,000	90
Ellis	Graded	73,032	2,500
	Gravel	19.559	77.2
Jim Hogg	Ungraded	3,000	30
Matagorda	Shell	28.000	150
Maverick	Gravel	20,000	96
Navarro	Graded	60,000	500
	Gravel	80.000	200
	Macadam	10,000	20
	Cement conc.	None	6
San Augustine	Gravel	12,000	27.5
Walker	Graded	25,000	300
Wilson	Graded	10,000	1,000
Washington:			
Adams	Macadam	43,000	280
Clallam	Gravel	200,000	775
Ferry	Gravel	9.000	30
Franklin	Ungraded	21,000	450
	Gravel & crushed rock	22,000	146
Lincoln	Gravel	45,000	280
	Cement conc.	150	3
Skamania	Graded	30,000	200
Thurston	Graded	3,000	200
	Gravel	80,000	600
	Cement conc.	15,000	50
Whatcom	Cement conc.	22,917	127.5
Whitman	Graded	128,000	2,800
	Gravel	5,000	100
	Macadam	30,000	110
	Bit. macadam	200	5
	Cement conc.	3,000	4.2
West Virginia:			
Gilmer	Ungraded	10,000	800
	Graded	15,000	30
Wisconsin:			
Ashland	Graded	65,000	165
Bayfield	Ungraded, graded, top soil, sand-clay, gravel & macadam	*68,846	287
Dane	Graded	3,782	5.5
	Gravel	46,894	37.9
Douglas	Graded & gravel	86,287	356
Jefferson	Gravel	70,000	275
Rock	Gravel	52,965	411.5
	Cement conc.	5,635	65.1
Waushara	Gravel	52,000	250
Wyoming:			
Campbell	Graded	1,814	126

*Includes $13,187 for road oil.

Gravel Roads in 1925

County	Constructed during 1925 Miles	Cost	Total in county at end of 1925	Average width of improved surface
California				
Fresno	....	......	66.82 (oiled)	16
Plumas	6	......	50	18
Colorado				
Otero	....	$14,000c	12	28
Routt	6 ½	......	....	..
Idaho				
Twin Falls	26	73,450c	94.85	26
Illinois				
Carroll	....	......	65	16
Kane	20	100,000c	500	18
McHenry	90	54,000c	750	24
Pulaski	3	4,800c	80	16
Saline	3 ¾	39,000a	....	12
Wabash	33	70,000d	190	9
White	18	54,000d	80	10
Williamson	....	34,000c	2	16
Indiana				
Carroll	13	6,000	570	..
De Kalb	69 ½	3,000ae	266 ½	14
Jay	12	75,000c	482	14
Kosciusko	24	6,000ae	171	14
La Grange	12	25,000c	110	28
Iowa				
Calhoun	48	49,084a	....	..
Cherokee	12.0	6,668a	16.2	26
Chickasaw	4 ½	3,866d	44	24
Delaware	....	......	40	24
Des Moines	....	......	7	26
Dickinson	15	15,000a	....	..
Dubuque	1	2,000a	....	..
Emmet	....	......	172.5	26
Fayette	28	35,611	155.6	26
Grundy	6	8,000a	22	20
Howard	5	4,500d	38	28
Jones	....	......	15	20
Kossuth	95	......	450	26
Lyon	18	19,121d	38.5	24
Marshall	43	97,000d	79	24
Muscatine	5.05	9,356a	4.44	24
Palo Alto	41.50	38,000d	185	26
Pottawattamie	....	......	....	26
Scott	....	......	34	20
Union	7.5	......	....	26
Woodbury	....	......	....	30
Kansas				
Anderson	....	......	30	28
Haskell	3	......	....	28
Hodgeman	....	......	....	28
Jackson	1.5	3,400c	1.5	18
Maryland				
Kent	....	......	10	15
Michigan				
Branch	24	100,000c	250	9
Calhoun	15.2	93,493a	385	9
Chippewa	15	150,000c	206	26
Houghton	8.2	......	13.2	16
Isabella	....	......	400	9
Keweenaw	4	15,000a	10	24
Leelanau	6.86	34,527a	87.30	16
Ogemaw	4	34,532c	107	12
Oscoda	5.5	90,000	28.2	16
Minnesota				
Beltrami	3	3,100c	....	20
Cass	....	......	18	24
Chippewa	16 ½	16,319a	....	..
Cottonwood	30	30,000a	100	18
Dakota	33	......	339	..
Dodge	22.77	35,408	....	24
Faribault	33	46,952b	286	24
Goodhue	27	55,135	....	24
Grant	18	18,000	80	24
Houston	4.2	......	9.07	..
Hubbard	....	......	17.51	24
Jackson	6.5	4,369c	102	20
Lake	10	6.000c	300	24
Lincoln	37	34,181a	94	24
McLeod	57.5	270,000c	821	30
Marshall	....	......	128	24
Martin	35.5	......	156.9	24
Mower	54.4	76,828d	154.4	22
Nobles	39.5	38,286c	183	24
Olmsted	8	13,042d	88.9	..
Otter Tail	42	37,000b	133	24
Pennington	8	9,690d	82	..
Pine	9 ½	13,000d	50	20
Pipestone	14.6	15,000c	91.4	20
Redwood	....	......	203.5	24
Rice	....	......	262.66	24
Rock	7.3	8,780	99	24
Roseau	0.4	......	20.85	20
Sherburne	5.75	8,511d	58	..
Sibley	6.5	......	685.9	20
Stearns	28	40,000c	300	16
Steele	12	16,500c	....	..
Swift	20	71,000a	106	20
Washington	5.6	27,530a	64	24
Watonwan	11 ½	16,883b	120	..
Wilkin	23	51,703	33	24
Mississippi				
Jefferson Davis	57	310,000c	57	24
Jones	60	3,000a	....	24
Lafayette	1 ½	12,000a	....	..
Stone	36	100,000c	....	30

Gravel Roads in 1925

County	Constructed during 1925 Miles	Constructed during 1925 Cost	Total in County at end of 1925	Average width of improved surface
Missouri				
Audrain	....	......	10	..
Cole	250	......	....	..
Marion	22	47,000a	215	28 to 30
Monroe	7	80,000b	30	..
Pulaski	2	600d	5	18
Putnam	8	......	14	16
Scott	....	.....	195	9
Washington	....	......	100	..
Montana				
Beaverhead	10	10,000a	150	18
Chouteau	....	......	....	12
Gallatin	17.67	130,620a	111.45	16
Hill	42	......	....	..
Lake	....	......	40	12
Nebraska				
Butler	28	......	....	..
Loup	....	....	....	24
Sarpy	17	42,500a	25	24
Nevada				
Eureka	45	......	45	20
White Pine	5	......	30	10
North Dakota				
McLean	8	17,821a	....	..
Ohio				
Cleveland	....	......	3.20	..
Darke	50	55,000a	150	18
Defiance	....	......	353	..
Holmes	....	......	58.7	16
Logan	....	153,400a	....	16
Medina	....	......	2.6	12
Morgan	14	52,000a	55	16
Muskingum	10	30,000c	....	16
Preble	13	50,000c	773.44	16
Oklahoma				
Craig	4	12,000	....	..
Le Flore	22.5	380,000c	66	..
Oregon				
Douglas	15	......	656.2	12
Lincoln	15	7,000a	110	9
Linn	30	......	2,000	16
Pennsylvania				
Erie	25	......	....	16
South Dakota				
Faulk	40	2,500b	....	..
Pennington	10	......	34	..
Roberts	20	17,000a	....	..
Spink	50	......	....	24
Texas				
Brooks	10	163,000c	44	18
Denton	9	35,000c	119	16
Ellis	77.25	438,126c	170	16
Gonzales	....	......	67	..
Maverick	....	......	40	60
Navarro	10	50,000c	200	20
Red River	....	......	7.25	16
San Augustine	2 ½	10,000c	....	24
Taylor	....	10,000ce	115	..
Washington				
Clallam	25	317,000c	800	20
Ferry	12	17,000e	45	12
Franklin	15	64,000a	193	12
Lincoln	30	135,000a	310	16
Skagit	....	......	570.53	24
Skamania	2	8,000a	....	16
Thurston	11	76,000a	600	24
Whatcom	....	......	240	..
Whitman	4	4,000d	100	16
Wisconsin				
Ashland	10	1,600d	....	..
Bayfield	....	......	20	26
Dane	117.12	235,879c	....	..
Douglas	30 ¼	59,267d	....	24
Rock	29	100,594c	411 ½	15
Jefferson	24	78,000a	200	18
Waukesha	17	60,000a	...	24

a—Includes grading. b—Includes bridges. c—Includes grading and bridges. d—Includes neither grading nor bridges. e—Per mile.

Waterbound Macadam in 1925

County	Constructed during 1925 Miles	Constructed during 1925 Cost	Total in County at end of 1925	Average width of improved surface
Georgia				
Spalding	2½	$46,994a	13	18
Idaho				
Twin Falls	....	......	2.85	..
Illinois				
Carroll	....	......	20	10
Douglas	....	......	38	12
Indiana				
De Kalb	....	......	1 ¾	..
Iowa				
Jones	....	......	2	..
Scott	....	......	6	..
Maryland				
Kent	....	......	25	15
Michigan				
Chippewa	2	$17,000c	52	..
Dickinson	....	......	11	..
Houghton	....	......	14	16
Keweenaw	....	......	18	..
Leelanau	....	......	4	..
Minnesota				
Houston	....	......	4.7	..
Olmsted	2	10,732d	5.0	..
Missouri				
Audrain	....	......	1	..
Monroe	....	......	5	..
Montana				
Gallatin	....	......	5.50	18
North Carolina				
Henderson	6	......	....	..
Ohio				
Brown	151	......	....	..
Cuyahoga	....	......	10.71	18
Defiance	13.59	110,475c	59	12
Holmes	....	......	7.5	.
Medina	....	......	2.7	10 to 16
Morgan	....	......	36	..
Muskingum	....	......	18	16
Williams	2	......	....	..
Wood	23	236,500c	133	16
Oregon				
Washington	19.62	137,231c	28	..
Texas				
Navarro	1	5,000c	20	16
Washington				
Adams	18.06	108,000a	301.37	16
Whitman	10	30,000d	110	16
West Virginia				
Mineral	3	30,000d	....	..
Wisconsin				
Bayfield	....	......	3	..

a—Includes grading. b—Includes bridges. c —Includes grading and bridges. d—Includes neither grading nor bridges.

Top Soil in 1925

Illinois				
Greene	....	......	110	..
McHenry	....	......	120	..
Maryland				
Kent	....	......	400	15
Minnesota				
Hubbard	7	$23,000a	48.8	..
Nevada				
White Pine	13	1,300a	50	10
North Carolina				
Chatham	20	......	175	24
Henderson	12	......	..	..
North Dakota				
McLean	57	4,053a	1,113	18
Ohio				
Logan	....	80,000a	....	..
South Carolina				
Greenwood	13	138,000b	130	..
South Dakota				
Pennington	28	......	255	..

a—Includes grading. b—Includes grading and bridges.

Bituminous Macadam Laid in 1925

Florida:				
Charlotte	..	$1,710,000c	..	16
Idaho:				
Twin Falls	..	..	19.35	..
Illinois:				
Du Page	6	217,122a	20	20
Kansas:				
Crawford	..	..	4	26
Michigan:				
Chippewa	..	..	2	..
Dickinson	..	..	4	..
Houghton	..	..	33	16
Keweenaw	..	..	2.5	..
Ohio:				
Cuyahoga	..	..	3.20	..
Darke	..	..	1.6	..
Defiance	..	..	81.3	..
Jefferson	4.75	108,000c	..	..
Medina	2.6	58,326c	25	18
Muskingum	3.9	70,865c	3.93	16
Preble	..	..	27	16
Williams	5	..	..	..
Wood	23	236,500c	133	16
Texas:				
Denton	..	..	10	18
West Virginia:				
Mineral	6	120,000d	..	..

A—Includes grading. b—Includes bridges. c—Includes both grading and bridges. d—Includes neither grading nor bridges.

Cement Concrete Paving in 1925

County	Concrete Reinforced: Constructed during 1925 Miles	Concrete Reinforced: Constructed during 1925 Cost	Concrete Reinforced: Total in County at end of 1925	Concrete Reinforced: Average width of improved surface	Concrete Not Reinforced: Constructed during 1925 Miles	Concrete Not Reinforced: Constructed during 1925 Cost	Concrete Not Reinforced: Total in County at end of 1925	Concrete Not Reinforced: Average width of improved surface
Colorado:								
Otero	....	....	....	....	....	$71,000c	2.3	....
Illinois:								
Carroll	....	....	....	....	13	360,000c	40	18
Champaign	....	....	....	....	29	551,000c	125	9
Douglas	....	....	18.11	9 & 18	....	....	5.12	9 & 16
Du Page	21	$504,089a	75	18	....	....	....	....
Jasper	....	....	....	....	11	330,000d	20	30
Kane	6	150,000c	99	18	....	....	....	....
McDonough	....	....	....	....	....	....	60	18
McHenry	....	....	....	....	27	756,000c	85	30
Menard	6.26	123,972d	12.25	16 to 18	....	....	....	....
Pulaski	18	....	....	....	....	....	....	....
Saline	30,000e	113,000a	....	....	....	....	....	....
Sangamon	....	....	....	....	....	....	107	30
White	....	....	....	....	18	350,000d	....	....
Williamson	....	....	43	18	....	....	....	....
Indiana:								
Carroll	1	30,000	....	....	....	....	....	....
DeKalb	1	....	4¾	18	....	....	....	....
Kosciusko	....	....	....	....	12	252,000a	65	16
Iowa:								
Dickinson	5	240,000a	....	....	....	....	....	....
Kossuth	....	....	13	18	....	....	....	....
Marshall	22	614,000d	29	18	....	....	....	....
Palo Alto	....	....	11	18	....	....	....	....
Pottawattamie	....	....	¾	....	....	....	....	....
Scott	12	310,166c	45	18	....	....	....	....
Taylor	....	29,901b	....	....	....	....	....	....
Woodbury	....	....	....	20	....	....	....	....
Kansas:								
Crawford	....	....	30	26	....	....	....	....
Riley	....	....	0.20	....	....	....	....	....
Sedgwick	....	....	....	....	....	....	37.5	18
Maryland:								
Kent	....	....	....	....	2	27,000c	15	12
Michigan:								
Branch	....	....	30	20	....	....	....	....
Calhoun	....	....	40	....	....	....	....	....
Dickinson	....	....	4	....	....	....	....	....
Houghton	....	....	....	....	....	....	0.5	30
Isabella	....	....	....	....	....	....	9	....
Keweenaw	....	....	....	....	....	....	1.3	....
Minnesota:								
Carlton	....	....	9.0	18	....	....	....	....
Dakota	11	58,435	40	....	....	....	....	....
Houston	....	....	0.68	....	....	....	....	....
Rice	....	....	.87	18	....	....	....	....
Missouri:								
Mississippi	....	....	....	....	8	160,000c	58	9
Newton	22	....	....	....	....	....	....	....
Scott	....	....	....	....	....	....	5	18
Montana:								
Gallatin	....	....	....	....	....	....	3.79	18
Nebraska:								
Butler	....	....	....	....	1	....	....	....
Sarpy	....	....	¼	....	....	....	....	....
Nevada:								
White Pine	....	....	....	....	....	....	0.58	....
North Carolina:								
Henderson	....	....	....	....	12	....	....	....
Washington	....	....	....	....	11	....	....	....
Ohio:								
Cuyahoga	16.68	843,396a	83.96	18	....	....	....	....
Darke	0.3	12,000a	233	16	....	....	....	....
Defiance	5.6	156,372c	46.7	16	....	....	36	16
Holmes	....	....	0.9	....	....	....	20.7	....
Jefferson	15.5	733,800c	....	....	....	....	....	....
Logan	....	90,000a	....	....	....	....	....	....
Medina	1.1	45,303c	10.5	18	2.8	87,037c	89.6	18
Muskingum	....	....	26.03	14-16 & 17	....	....	....	....
Preble	....	....	....	....	....	....	7.3	16
Williams	½	....	....	....	....	....	....	....
Wood	....	....	11	16	....	....	....	....
Oregon:								
Douglas	....	....	....	....	0.5	....	3.0	....
Pennsylvania:								
Carbon	3	150,000a	....	....	16	....	....	....
Erie	20	800,000c	216	16 to 18	....	....	....	....
South Carolina:								
Greenwood	....	....	....	....	....	....	3.25	18
Texas:								
Navarro	....	....	6	9	....	....	....	....
Red River	....	....	4	....	....	....	....	....
Washington:								
Lincoln	....	....	....	....	....	....	3	18
Skagit	....	....	....	....	4.8	141,125c	85.49	24
Thurston	....	....	....	....	....	....	50	....
Whatcom	....	....	....	....	7	201,344	134.5	20
Whitman	10.2	300,000d	14.5	18	....	....	....	....
West Virginia.								
Mineral	....	....	....	....	1.0	40,000d	....	....
Wisconsin:								
Dane	0.23	4,341c	....	20	....	....	....	....
Rock	....	....	....	....	17.4	402,978c	82.5	18 & 20

a—Includes grading. b—Includes bridges. c—Includes grading and bridges. d—Includes neither grading nor bridges. e—Square yards.

Sand-Clay Roads in 1925

County	Miles constructed during 1925	Cost	Miles in county at end of 1925	Average width of improved surface, feet
Florida:				
Bradford	...	....	10	..
Iowa:				
Muscatine	...	....	7.95	..
Kansas:				
Barton	6	....	8	20
Harvey	15	$27,348a	....	..
Pawnee	...	....	38	18
Sedgwick	4.6	14,200a	20	24
Maryland:				
Kent	...	....	75	15
Michigan:				
Houghton	...	....	54.1	16
Keweenaw	2½	7,800a	26	24
Minnesota:				
Cass	...	....	142.1	24
Houston	...	....	3	..
Otter Tail	...	....	65	..
Roseau	...	....	0.50	..
Sherburne	...	....	1.5	..
Nebraska:				
Loup	4	3,600a	6	24
North Carolina:				
Henderson	18	....	....	..
Ohio:				
Logan	...	160,000a	....	..
Texas:				
Jim Hogg	1.3	....	....	..
Matagorda	2	800b	10	..
Wisconsin:				
Ashland	10	1,200	....	..
Bayfield	..	....	59	24

a—Includes grading. b—Includes grading and bridges.

Brick Pavement Laid in 1925

Illinois:				
Douglas	....	....	12¾	9 & 10'
Sangamon	....	....	11	30
Indiana:				
De Kalb	....	....	2¼	..
Iowa:				
Scott	....	....	23.5	..
Kansas:				
Crawford	....	....	5	26
Riley	....	....	1.10	20
Sedgwick	....	....	23.5	18
Michigan.				
Calhoun	....	....	5.7	..
Nebraska:				
Sarpy	0.6	$22,000a	1.1	22
North Carolina:				
Washington	....	2,400b	..	..
Ohio:				
Cuyahoga	8.17	1,070,312a	277	18
Darke	....	....	18	16
Holmes	....	....	11.1	..
Jefferson	2.0	150,000c	..	..
Medina	2.0	49,468c	11.2	10 to 18
Morgan	....	....	5	16
Muskingum	....	....	37.95	14 & 16
Preble	....	....	8.16	17
Wood	....	....	7	..

a—Includes grading. b—Includes bridges. c—Includes grading and bridges.

Highway Expenditures in 1925, by States

State	Federal aid paid in 1925	Fur. by state for high'y w'k	Fur. by counties, towns or other sub'div'n of state
Arizona	$ 709,729	$ 828,655a	$ 45,000
Arkansas	1,850,000	3,150,000	2,200,000
Colorado	1,443,655	2,086,486	....
Connecticut	109,200b	9,516,560	....
Delaware	365,000	1,541,065	747,754
Florida	887,367	7,416,680	628,938c
Georgia	3,250,000	1,400,000	2,200,000
Idaho	1,142,431	1,142,431	721,822
Illinois	2,717,923	33,388,679	15,000,000
Kansas	2,405,066	3,000,000	3,500,000
Kentucky	3,330,000	2,500,000	2,000,000
Maine	445,746	4,230,942	1,229,286
Maryland	635,783	2,300,000	600,000
Michigan	16,626,840	....	....
Mississippi (i)	3,400,000	100,000	3,300,000
Missouri	2,417,727	23,615,143	....
Nebraska	2,300,000	2,000,000	300,000
Nevada	1,735,000	....	1,245,000d
New Hampshire	602.834	2,661,143	1,600,928
New Mexico	2,000,000e	700,000f	....
North Carolina	27,827,056g	....	....
North Dakota	1,198,000	599,000	599,000
Ohio	2,525,755	4,148,260	6,500,000
Oregon	1,327,329	5,976,585	1,389,744
Pennsylvania	5,166,438	50,050,375	7,077,554
Rhode Island	650,429h	1,850,000	10,000
South Carolina	1,005,791	4,922,365	....
South Dakota	1,709,548	2,930,464	....
Texas	4,769,543	3,838,182	3,500,000
Utah	1,208,727	498,378	748,480i
Vermont	389,798	940,450	444,723
Washington	1,216,266	6,577,120	51,778
West Virginia	854,888	9,953,414	7,000,000
Wisconsin	2,540,000	3,395,000	330,000
Wyoming	1,416,083	1,385,365	749,186c

a—For highway construction only. b—Includes unfinished contracts. c—By counties. d—Includes amount furnished by state. e—For Federal aid projects; part of this for work completed in 1924 but accepted and paid for in 1925. f—For maintenance. g—Total expenditure from all sources. h—Includes state's appropriation to meet Federal aid allotment. i—Includes only work done under supervision of state highway department.

Road Construction and Maintenance

The figures in the accompanying table have been compiled by the Bureau of Public Roads from its records and from estimates made by highway officials of the various states. Of the amount of probable expenditure by the states, about $461,515,400 will be used for construction and $137,075,548 for maintenance.

Funds available during 1926 for Construction and Maintenance of Rural Roads.

	Probable Expenditure by State Highway Department	Federal-aid Funds Available to States*	Probable Expenditure by Local Authorities
Alabama	$9,900,000	$3,547,911.69	$12,000,000
Arizona	4,200,000	3,084,742.68	630.000
Arkansas	6,500,000	1,534,751.77	9,000.000
California	14,000,000	4,248,299.76	23,000.000
Colorado	4,550,000	3,285,370.65	5,000.000
Connecticut	7,785,289	1,611,062.57	2,500.000
Delaware	2,930,000	367,537.65	900.000
Florida	14,000,152	1,400,910.74	18,000.000
Georgia	7,324,750	1,931,087.02	13,000.000
Idaho	2,837,000	1,271,409.28	1,500.000
Illinois	46,200,000	6,674,248.74	20,000,000
Indiana	13,200,000	2,382,667.87	40,000,000
Iowa	13,584,108	4,028,631.46	16,000.000
Kansas	9,072,000	3,073,831.15	10,000,000
Kentucky	12,000,000	2,486,349.23	10,000.000
Louisiana	9,250,000	1,856,350.57	7,000.000
Maine	8,983,400	1,513,478.38	3,900.000
Maryland	7,116,398	654,830.74	3,200.000
Massachusetts	13,000,000	2,673,200.94	12,000,000
Michigan	11,500,000	4,603,378.63	22,000.000
Minnesota	21,500,000	2,111,863.44	6,500.000
Mississippi	6,250,000	1,698,458.08	6,000.000
Missouri	28,076,000	2,600,235.10	12,000.000
Montana	1,350,000	5,714,746.27	1,000.000
Nebraska	6,500,000	3,941,841.00	8,500.000
Nevada	1,670.000	1,049,593.49	400.000
New Hampshire	3,550,000	511,347.83	1,500.000
New Jersey	22,900,000	985,680.83	8,300,000
New Mexico	3,555,553	2,750,373.17	200,000
New York	35,750,000	6,938,224.36	26,641.000
North Carolina	16,000,000	1,715,137.99	10,000.000
North Dakota	5,450,000	2,506,152.20	3,500.000
Ohio	25,500,000	4,502,826.16	20,000,000
Oklahoma	10,000,000	1,894,068.61	12,000,000
Oregon	7,000,000	1,319,943.74	7,000.000
Pennsylvania	63,550,000	3,699,149.10	12,500,000
Rhode Island	3,790,000	675,753.65	875.000
South Carolina	5,540,000	892,885.46	2,500,000
South Dakota	3,350,000	1,282,672.87	5,250,000
Tennessee	18,000,000	2,374,596.79	9,000.000
Texas	28,000,000	4,979,640.84	16,000,000
Utah	3,640,798	1,502,010.18	500,000
Vermont	3,530,000	801,796.98	700,000
Virginia	10,285,500	1,481,535.84	2,600,000
Washington	9,000,000	1,527,002.22	11,000,000
West Virginia	13,750,000	912,454.24	6,000,000
Wisconsin	20,970,000	5,143,634.95	10,700,000
Wyoming	2,200,000	1,024,811.51	900,000
Totals	$598,590,948	$118,768,488.42	$431,696,000

*Included in total probable expenditure by State highway departments.

The reports indicate that the states plan to maintain 234,582 miles of road, and to construct 29,216 miles, of which 6,751 miles will be durable surface (asphalt, concrete, brick, etc.), 14,320 miles sand-clay, gravel and macadam, and 8,145 improved earth. That is, about 77 per cent will be low-grade type of construction.

Miscellaneous Pavements in 1925

County	Kind of Pavement	Miles constructed during '25	Cost	Miles in county at end '25	Aver. width of impvd sur. ft.
Florida:					
Sarasota	Sheet asphalt	..	......	25	24
	Asphalt block	¾	$28,740c	¾	18
	Fla. lime rock base, double surface treated	15	117,000c	..	16
Illinois:					
Douglas	Oiled earth	..	......	310	8 to 16
Indiana:					
Putnam	Sheet asphalt	1¼	11,600d	..	..
Kansas.					
Crawford	Shale	..	......	2	26
Riley	Sheet asphalt	..	......	2.0	..
Michigan:					
Calhoun	Sheet asphalt	..	......	2½	..
Ohio:					
Cuyahoga	Sheet asphalt	..	......	6.94	18
	Travel-bound macadam	..	......	..	18
Defiance	Kentucky rock	..	......	8.0	14
Jefferson	Not named	25.2	161,400c	..	..
Medina	Traffic-bound macadam	..	26,004c	68.0	9
Muskingum	Kentucky asphalt	..	......	2.7	14
Preble	Kentucky asphalt	..	......	1.1	16
Oregon:					
Douglas	Plank	1.0	......	18.5	1.0
Washington	Not named	..	3,018c	..	..
Texas:					
Bee and Brooks	Resurfaced caliche	10.3	12,000c	57	18
Gonzales	Uvalde rock asphalt	..	......	18	18
Red River	Asphalt top	..	......	17	..
Williamson	Sledged stone base	..	......	6	..
Washington:					
Skagit	Doloway	..	......	.75	..

a—Includes grading. b—Includes bridges. c—Includes grading and bridges. d—Includes neither grading nor bridges.

Road Improvement in 1925 Under State Supervision

From information furnished by State Highway Officials

State	Grading only Miles	Sand-clay & top-soil Miles	Gravel Miles	Plain Macadam Miles	Bit. Macadam Miles	Bit. Concrete Miles	Cement Concrete Reinforced Miles	Cement Concrete Not Re'f'od Miles	Brick Miles	Sheet Asphalt Miles	Rock Asphalt Miles	Other Kinds: Kind	Other Kinds: Miles
Arizona	7.73	......	75.39	......	......	7.16	......	1.77	......	......	......	Flush coat on asphalt	10.0
Arkansas ...	400	......	700	......	......	25	......	119	......	......	......	....	......
Colorado ...	8.37	93.09a	......	......	......	1.9	......	28.16	......	......	......	....	......
Connecticut	2.10	......	1.19	30.74	16.88	5.15	57.51	......	......	......	......	....	......
Delaware ...	......	......	......	......	......	......	......	72	......	......	......	Secondary slag macadam	1.0
Florida	55.02	85.45	......	......	......	5.12	......	18.90	......	12.72	......	Marl Surface treated rock base	0.36 108.75
Georgia	25.7	133.9	112.6 b	4.8	16.5	7.7	......	56.1	......	......	......	Surface treated	17.9
Idaho	11.37	......	9.75	82.97	......	......	......	11.45	......	......	......	....	......
Illinois	197.08	......	7.64	1.26	......	......	......	882.75	9.12	......	5.63	....	......
Kansas	172	16	36	......	25	......	......	27	20	......	......	Chat	5
Kentucky ..	176	......	75	77	20	......	47	......	......	......	15	....	......
Maine	......	......	295.92	0.10	26.8e	......	1.86	......	......	......	......	Granite block	0.74
Maryland ..	0.65	......	42.74	18.83	......	......	......	99.19	......	5.40	1.00	Amiesite	2.00
Michigan ...	......	......	194.34	3.51	14.06	16.65	224.34c	......	......	0.21	......	....	......
Mississippi .	76	......	328	......	......	......	......	52	......	......	......	....	......
Missouri ..	388	......	348	......	11	......	......	455	......	......	......	....	......
Nebraska ..	465	40	906	......	......	0.5	......	19.0	0.5	......	......	....	......
Nevada	45.49	......	190.71	......	......	0.37	......	4.58	......	......	......	Graveling roads previously graded	10.58
N. Hampshire	......	6.38	84.93	3.97	18.56	5.45	4.54	......	......	......	......	Surface treated gravel	19.17
New Mexico.	20	......	65	......	......	......	......	5	......	......	......	....	......
No. Carolina	505	276	97	......	109	131	......	319	......	......	......	Sand asphalt	107
N. Dakota...	426	......	260	......	......	......	8	......	......	......	......	....	......
Ohio	68	......	31	24	109	10	103	40	47	11	24	Other kinds Reconstruction	25 27
Oregon	177.2	......	146.1 d	......	......	0.6	......	7.6	......	......	......	....	......
Rhode Island	......	......	......	2.9	14.7	......	15.0	......	......	2.6	......	....	......
S. Carolina..	88.85	639.60	42.13	11.63	......	34.01	......	69.76	......	17.51	......	....	......
S. Dakota ..	111.2	......	551.4	......	......	......	......	......	......	......	......	....	......
Texas	334.40	37.77	407.05	69.83	229.31	30.03	103.52c	......	17.81	......	73.27	Other kinds	77.39
Utah	......	......	102	......	......	0.47	......	3.57	......	......	......	....	......
Vermont	205	......	120	......	6.72	......	6.23	......	......	......	......	....	......
Washin'tn ..	51	......	91	......	......	......	60c	......	......	......	......	....	......
W. Virginia.	260.18	......	65.07	30.41	98.41	9.70	......	51.29	4.60	......	16.95	Shale	8.24
Wisconsin	1010.9	......	1144.3	......	0.8	......	......	137	......	......	......	Shale Crushed stone	47.0 65.3
Wyoming	197	......	92	......	......	......	......	......	......	......	......	....	......

a—Includes gravel and crushed rock. b.—Includes chert. c—Includes not reinforced. d—Includes broken stone surfacing.

Surface Treatment of Roads

When and how to give an asphalt or tar treatment to macadam and gravel roads. Avoid building up a thick mat. Specifications for asphalt and tar.

Discussing the subject of the surface treatment of roads before the American Road Builders' convention, John N. Mackall, chief engineer of the Maryland Highway Department, stated that if sufficient attention could have been given to this subject fifteen or even ten years ago, many millions of dollars would have been saved to the tax payers and there would be many more hundreds of miles of good travelable macadam and gravel roads in America today, which have been permitted to go to pieces either from lack of surface treatment or from an excess of surface treatment.

The chief reason why surface treatment has not been more generally adopted is, in his opinion, because of the unpopularity of such treatment due to the annoyance caused by the methods employed. Possibly if the highway administrators had informed the tax payers, when building a durable pavement which did not require occasional surface treatment and removing a comparatively good macadam pavement to do so, that the new pavement would cost two or three times as much annually as the maintenance on the old pavement, the public might not have been so anxious to pay for the new type.

WHEN TO SURFACE TREAT.

The difficult and really essential thing about surface treatment is to know when it is to be done. "The nearest safe rule I can give is to put off surface treatment work as long as it is possible to put it off, and then wait another year before actually applying it. This rule may at times cause considerable patching before another year rolls around, but the probabilities are that the patching will not be more than mildly troublesome and slightly expensive, while additional surface treatment before one is needed will invariably bring about the destruction of the road through the creation of transverse waves which will make the road unsatisfactory if not impossible to use.

"The road ideally maintained under surface treatment is one which has a continuous film of bituminous material, impervious to water, over the entire surface of the road and of no appreciable thickness. One application to a new road will form a mat which will give some wear. A second application the second year will add something to the depth of the mat and something to its uniformity. An application for the third and fourth years will invariably destroy the road by the building up of a mat of excessive thickness which will set up transverse waves, for which there is no remedy except to completely remove them. This, in most cases, means completely scarifying and resurfacing the entire section of the road. On the other hand, the allowance of too much time between successive treatments will permit the surface of the road to disintegrate and it may be destroyed from this cause. It has been my observation, however, that many more roads have been destroyed from too much treatment than from too little."

MACADAM ROADS

Mr. Mackall gave definite instructions for surface treating both macadam and gravel roads. For gravel roads, he stated that the road should be examined either in the late fall or the early spring to determine whether it needed surface treatment. Treatment may seem necessary to a road in winter, which will greatly improve in the spring when life returns to the bituminous material in it. If there is merely a place here and there which needs surface treatment, such treatment should be delayed, as a general thing, until there is surface disintegration over at least 5 per cent. of the total area of the surface.

Concerning the materials to be used, he states that for the first application he has found tar more satisfactory than asphalt, but after the initial application either gives equally satisfactory results.

Where asphalt is used, they have obtained best results in Maryland by fluxing an asphalt cement of 120 to 150 penetration with naphtha which, when distilled in accordance with the A. S. T. M. method, has an overpoint of not greater than 225 degrees, while the dry point does not exceed 450 degrees. The prepared oil must conform to the following specifications and must be homogeneous and free from water:

	Min.	Max.
Specific gravity at 25°C.	0.93	—
Flash point, open cup, °C.	—	65
Evaporation loss, 20 g. 5 hrs., 212°F. (100°C.) by weight	22%	—
Evaporation loss, 20g. 5 hrs., 325°F. (163°C.) by weight	27%	—
Consistency of residue after evaporation:		
Pentration at 25°C. of residue of 20 grs., 325°F. loss	—	100
Specific viscosity (Engler) first 50 c. c. at 40°C.	40	60
Insoluble in 86° Naphtha	14%	—
100 Pen. asphaltic content (open evaporation at temperature not to exceed 500°F.)	68%	—

Coal gas tars must be homogeneous, contain not more than two per cent of water and conform to the following analysis.

Specific gravity at 60° F.	1.15	119
Viscosity (Engler), first 50 c. c. at 40°C.	250"	350"
Insoluble in carbon bisulphite	6%	12%
Distillation (250 c. c.) (Engler Flask):		
Up to 170°C.	—	7%
Up to 235°C.	—	18%
Up to 270°C.	—	35%
Up to 300°C.	—	43%

Water Gas Tars

	Min.	Max.
Specific gravity at 25°C.	1.10	1.14
Viscosity (first 50 c c. at 40°C.)	250″	350″
Insoluble in carbon bisulphite	—	4%
Distillation (250 c. c.) (Engler Flask):		
Up to 170°C.	—	2%
Up to 235°C.	3%	15%
Up to 270°C.	18%	30%
Up to 300°C.	25%	40%
Melting point res. (Ring and Ball method)	30%	60°C

In the matter of treatment, the weather is a very important consideration. In Maryland, no surface treatment is done after the first day of July, nor before the first day of October; the object being to avoid applying it in very hot weather. Even though as little as .2 gallon per square yard is applied, in excessively hot weather it will work down toward the edges from the center and render unsuccessful all attempts at uniform distribution. Material such as that specified must be heated and should be applied by means of pressure distributers.

He has found a fair day's work to be 5,000 gallons of material applied at the rate of ¼ gallon per square yard, which will cover a little more than two miles of 16-foot roadway. Before applying the bituminous material, stone chips or clean gravel passing a one-inch ring and free from dust is piled along the side of the road at intervals of about 15 feet, the quantity being sufficient to furnish about 20 pounds to the square yard. He has found that distributing by hand is superior to any of the mechanical distributors which he has tested.

For each pressure distributor, there should be not less than three power rollers. He prefers gasoline rollers, for he has found that with steam rollers at least one-third of the time is occupied in firing and getting up steam, and another third in taking on water, so that no more than one-third of the time is left for rolling; while with a gasoline roller there is no excuse for not rolling continuously. Two of the rollers are kept immediately behind the distributor and the third used for rolling material which has been down 24 hours.

Treatment should be applied to one side of the road at a time, leaving the other open for traffic, and the covering gang should never be more than a short distance behind the distributor. Traffic can safely be allowed on the road within two hours after the bituminous material has been covered. Bituminous materials, especially asphalts, seem to cut back previous surface treatments so that there is apt to be some movement of the cover material during a period of about 48 hours. By means of signs and watchmen, the traveling public should be informed of what is going on, and advised to keep off of the freshly treated surface.

GRAVEL ROADS

"The surface treatment of gravel roads is a problem on which most of the experimental work of which I know has been done by Paul Sargent of Maine. The material which we have adopted and found most excellent in every respect was developed by him, and our method of application and treatment was obtained from him, and I take this opportunity to express my appreciation for what he has done for the surface treatment of gravel roads and congratulate him upon the results."

No asphalts are used on gravel roads but only tar, the Maryland highway department using chiefly Tarvia. The tar used must meet the following specifications:

1. Specific gravity 25°/25°C. (77°/77°F.) not less than 1.100
2. Specific viscosity at 40°C (104°F.).. 8 to 13
3. Total distillate by weight:
   To 170° C. (338°F.)............not more than 5%
   To 270° C. (518°F.)............not more than 32%
   To 300° C. (572°F.)............not more than 42%
4. Total bitumen (soluble in carbon disulphide) not less than 90%.

Tests of the physical and chemical properties of the tar shall be made in accordance with the following methods:

1. Specific gravity, Department of Agriculture, Bulletin 314, p. 4
2. Specific viscosity (on first 50 c.c.) U. S. Department of Agriculture Bulletin 314, p. 7.
3. Distillation test, A. S. T. M. Standard Test D20-16.
4. Total bitumen (soluble in carbon disulphide) not less than 90%.

The gravel roads in Maryland are composed of either screened or pit run gravel containing 60 percent of material larger than ¼-inch and a filler composed of an intimate mixture of sand and clay. The treatment of these roads should be somewhat different from those in which there is no clay in the filler.

A gravel road should not be treated unless it is in good condition. All weak spots should be discovered and completely removed and replaced with good material at least a month in advance of oiling, and the road should be kept dragged and graded to a good, uniform condition, free from corrugations and weak spots. It is essential that the surface of the road be dry when the tar is applied to it.

With the road in good condition, all loose material is removed by a rotary broom, supplemented by hand brooms where necessary. Tar is then applied at the rate of ½ gallon to a square yard with a pressure distributor and immediately covered with fine sand and gravel, using the material which was swept off the road if it does not contain clay. (In most cases the pulverized clay will be blown away as it is loosened by travel.) Such of this material as is worked to the side of the road by travel during the first day should be thrown back again the second day, care being taken to cover every spot which appears to be bleeding.

A traffic of 300 or 400 vehicles a day is usually sufficient to work the cover material into the tar, but if it is not, it may be supplemented by rollers, a four or five-ton roller being apparently as satisfactory as a ten-ton.

This first application is allowed to cure for about a month and a second application is then made. In Maryland, a single application gave no satisfactory results even for the first season; but when a second application was made, the surface carried satisfactorily through the winter

and, with an additional treatment the second year, appeared to be in a position to give two if not three years of service without an additional application.

Before making the second application, any weak spots which have developed are patched with a mixture of gravel and bituminous material; a cold patch material is used in Maryland for this purpose. This patching should be carefully done so that the surface of the road is perfectly smooth when the second application is made.

The second application is covered with a better material than that required for the first, coarse sand or a combination of sand with gravel no larger than ¼ inch being used. Before making the second application, all loose material and foreign substances are removed by scraper and hand broom. The tar is applied at the rate of ¼ gallon per square yard and immediately covered, the cover material being spread back onto the surface as fast as it is pushed off by travel, for a period of at least four days.

One of the really essential things about surface treatment of gravel roads is to keep applied to the surface an excess of covering material at all times so that the maximum amount may be worked into the surface during the curing period. If this material is allowed to be kicked off by vehicles and to lie along the edge of the travelled way, it will absorb a considerable amount of the tar which has been applied to the surface and this will eventually dry out and be of no value.

The slow curing asphaltic oils which have given satisfactory results on sand gravel roads have been a total failure on the clay gravel roads in Maryland.

Duration of Concrete Mixing

Studies by California Highway Commission indicate that batches should not be larger than the rated capacity of the mixer, and that longer mixing does not compensate for larger batches.

Studies have been made by the California Highway Commission having to do with the effect on concrete of variations in time of mixing and capacity of mixer. These studies and the conclusions therefrom were the subject of a short report by C. S. Pope, construction engineer, and C. L. McKesson, materials and research engineer, of the commission.

The standard specifications for California highways require that mixing continue for one minute after all ingredients have been placed in the drums and before any portion of them have been discharged, with a mixture of 1½ minutes where the concrete is to be used in reinforced structures. It is also required that the total volume of materials used in a batch shall not exceed the rated capacity of the mixer as given in the manufacturer's catalog. "It occasionally happens that the capacity of the mixer is the limiting element in the contractor's equipment, and in such cases it is economically desirable that the mixer be loaded to the maximum capacity at which it will operate efficiently. Sometimes maximum capacity is desirable to make the size of batch fit transportation equipment."

The latter consideration led to the first series of experiments. These were made on a 32E Koehring paver and later on a 21E Rex paver. In the case of the Koehring paver the rated capacity is 32 cubic feet of mixed concrete, the maximum capacity according to the manufacturers being 36 cubic feet.

It had been found on a certain job that a 10-sack batch, making 45 cubic feet of mixed concrete, was desirable if thorough mixing could be secured, because of the capacity of the batch boxes used on industrial cars. Accordingly, batches of this size were run, but the mixing time increased to 1½ minutes to compensate for the additional size of batch. A test was made on the character of concrete turned out when mixing 10-sack batches and 8-sack batches, and when continuing the mix for one minute and for two minutes. Compressive strengths were determined after 11 days and 28 days, samples being taken from concrete from the front of the mixer—that which issued first, and from the back of the mixer—that which issued last. With an 8-sack batch, the one-minute mix was found to have a higher compressive strength than the two-minute, although the latter had somewhat better workability and uniformity. "No reason is apparent as to why this phenomenon should have occurred, but the test did show conclusively that this mixer was properly designed to produce thorough mixing in one minute as specified so long as the batch is within the rated capacity."

In a later test made with a Rex paver, which is rated on the basis of a 5-sack batch for a 1:2:4 mix, tests were made of 5-sack and 6-sack batches. The drum held a 6-sack batch without slopping over. From the tests it appeared that the "mixer was properly rated by the manufacturers as having a 5-sack capacity on 1:2:4 concrete, and that an oversized batch results in decreased average strength."

The authors of this report draw the general conclusion that, "The studies so far completed seem to indicate that any increase in time of mix for any mixers now in common use between one minute and some undetermined time more than two minutes and less than five minutes is of no particular value so far as increase in strength is concerned." In general also, the larger batches had average compressive strength 10 per cent or more less than that of the batches corresponding to the rated capacity.

Prof. Abrams' studies indicate that there is a slight increase in strength as speed of rotation of mixers is increased from 15 r.p.m. to 30 r.p.m.. and possibly better design of internal mechanism of mixers will permit decreasing time of mix.

Recent Legal Decisions

STATES' RIGHT TO CHANGE LOCATION OF HIGHWAYS

The Tennessee Supreme Court holds, Tiles v. Creveling, 265 S. W. 628, that the state has full authority over its highways, and, in the exercise of the police power, may take them in charge, and, in the public interest, change the route of any highway. The state may act in such a matter either directly, by act of the Legislature, or may delegate such authority to a commission or a commissioner, as it has done by Acts 1917, c. 74; 1919, c. 149; 1923, c. 7.

The highway commissioners, it is held, could not make a contract as to the location of a road binding upon themselves or their successors in a case where it later appeared that a deviation from the route agreed upon was required by the public welfare. Any such contract is made subject to the right of the state to withdraw from it when the public safety so requires.

The county's consent is not necessary to the acquisition by the state highway commission of rights of way for a state highway system.

ROAD SUBCONTRACTOR'S FOREMAN NOT WITHIN STATUTORY BOND COVERING LABOR CLAIMS

The Missouri Court of Appeals holds, Missouri State Highway Commission v. Coopers Const. Service Co., 268 S. W. 701, that a road contractor's bond provision for payment of claims for labor under Mo. Rev. St., 1919, §§1040, 1041, does not include the services of a subcontractor's foreman in charge of the work, employing all labor and purchasing the gravel and necessary material to carry out the contract.

ROAD CONTRACTOR HELD NOT ENTITLED TO SUE ON CONTRACT FOR BENEFIT OF COUNTY AND HIGHWAY COMMISSION

Landowners executed an agreement obligating themselves to pay specified amounts and donate necessary land to induce a county and highway commission to locate a federal highway through their neighborhood. The commission contracted for the construction of the highway. Certain of the landowners, on the work reaching their farms, refused to allow the contractor to proceed. Injunction was granted to restrain interference with the work, and the contractors subsequently sued the owners who had breached their agreement for damages sustained by the delay caused by their acts. The Kentucky Court of Appeals held, Spurrier v. Burnett, 270 S. W. 25, that the contractors could not recover, the contract not having been made for their benefit.

CONTRACT FOR STATE AIDED ROADS BETWEEN TOWNSHIP AND HIGHWAY COMMISSION

In a mandamus action to compel the Oklahoma State Highway Commission to deliver to the officers of McElroy township $60,000, held by the commission as a result of a contribution under a contract between the township and the commission, where the commission had performed part of its contract by preparing plans and specifications of the roads to be constructed, the Oklahoma Supreme Court held, Avery v. Curtiss, 235 Pac. 195, that the township could not revoke its discretion after it had been exercised and rights had vested under the contract and compel the return of the money deposited with the commission; and that a peremptory writ of mandamus should not issue. When the township deposited the money, the proceeds of the sale of road bonds, with the commission, the township became vested with the right to have the commission match same with federal or state aid, and to have the commission contract for the construction of roads in the township, and the commission was vested with the right to use the money for this purpose in the interest of the state.

EVIDENCE AS TO VALUE OF ROAD SUPERINTENDENT'S SERVICES

In an action of a highway construction superintendent under the three-mile road law, for the compensation provided by Burns R. S. 1914, §7730, the Indiana Appellate Court holds, Board of Comrs. of Wabash County v. Mason, that evidence that the subgrade was not lowored to a sufficient depth, as required by the specifications; that the concrete base was a little less than 4½ inches instead of 6 inches, as required by the specifications; that in other particulars the road was not constructed according to specifications, and that the superintendent was derelict in not requiring the contractor to so construct it, was admissible as going to the value of the superintendent's services.

PROVISION IN CONTRACT BETWEEN ROAD CONTRACTOR AND SUBCONTRACTOR AS TO SUPPLYING MATERIAL HELD NOT A WARRANTY

The Texas Commission of Appeals holds, Perkins & Smith v. Perkins & Stiff, 272 S. W. 126, that a clause in a contract between a road contractor and his subcontractor that "Collin county will furnish all material * * * for said work" could not be construed as a warranty, or a contractual covenant on the part of the contractors, the breach of which would subject them to liability; but that it was intended to negative the idea that the contracors were under any obligation to furnish the material.

While the use of the word "warrant" is not indispensable, and no particular form or expression is necessary for the creation of a warranty, yet the language employed by the parties, when interpreted according to the ordinary rules of construction, must indicate with at least reasonable certainty an intention to enter into a contract of warranty, or such intention must be clearly implied from the language used and the whole situation of the parties.

DEFINITION OF MAXIMUM FEDERAL AID TO ROAD IMPROVEMENT DISTRICT

The Arkansas Supreme Court holds, Taylor v. Williams, 272 S. W. 852, that the term "maximum federal aid" in Ark. Acts 1925, No. 215, Sec. 2, providing federal aid to road improvement districts which cannot obtain the maximum of federal aid without issuing additional bonds or making addi-

tional assessments of benefits does not mean that a district cannot avail itself of the act unless it is given an allowance of federal aid equal to as large per cent. of the total cost of construction as has been made to any other district receiving federal aid. The highway department determines what aid may be given a particular district, and the largest sum allotted the particular district is the maximum of federal aid for that district within the meaning of the act.

PROCEEDS OF SALE OF HIGHWAY BONDS MAY BE USED FOR CONDEMNATION OF LAND FOR ROAD

The Texas Court of Civil Appeals holds, Stites v. Sutton County, 272 S. W. 506, that the money arising from the sale of county highway bonds, issued under Texas Rev. St. art. 627, providing for the issue of bonds "for the purpose of constructing and maintaining and operating macadamized, graveled, or paved roads and turnpikes, or in aid thereof," is not restricted in its use to the actual construction of the roadbed and the graveled surface or pavement, but may be used for the condemnation of the land necessary for the construction of the road.

"MATERIALS" UNDER PUBLIC WORKS CONTRACTOR'S BOND

While the authorities are not in accord on the question whether coal, hay, oil and other things consumed in the use are "material" used in road construction, the Circuit Court of Appeals, Fourth Circuit, Early & Daniel Co. v. American Surety Co., 5 F. (2d) 670, held that the question whether hay and stock feed consumed by the live stock employed on the North Carolina road contract were "materials" was governed by the state law, and held that they were within the contractor's bond. The court cited Pocahontas Coal Co. v. Henderson Electric Light & Power Co., 118 N. C. 232, holding that "material furnished" included coal consumed in running an engine used in the work, and Brogan v. National Surety Co., 246 U. S. 257, where it was said, considering the use of "material" in federal statutes: "This court has repeatedly refused to limit the application of the act to labor and materials directly incorporated in the work."

REPAIRS ON HIGHWAY AS DISTINGUISHED FROM REPAVING

The New Jersey Court of Errors and Appeals holds, Mayor, etc., of Jersey City v. Public Service Ry. Co., 129 Atl. 482, that the laying of a new pavement upon a public highway is not considered a "repair," under the New Jersey law. "The repaving of a highway is a public improvement, the cost of which may be imposed upon abutting owners to the extent to which their property is specially benefited by the improvement (Jelliff v. Newark, 48 N. J. Law 101, affirmed 49 N. J. Law, 239); while the cost of the repair of an existing pavement is not an improvement assessable upon property owners to the extent of the benefit resulting from that repair, but is payable out of the municipal treasury from funds raised by taxation (Hurley v. Trenton, 66 N. J. Law 538, affirmed 67 N. J. Law 350)." The obligation of a street railway company to keep the pavement between its rails and for two feet on the outside thereof in good repair, at its own expense, and according to the requirements of the governing body of the municipality, was held not to impose upon it the duty of paying a proportionate part of the cost of a new pavement whenever, in the judgment of the municipal authorities, it is to the interest of the municipality that such an improvement should be made.

LOAN BY COUNTY COMMISSIONERS TO HIGHWAY COMMISSION FOR ROAD CONSTRUCTION HELD VALID

The North Carolina Supreme Court holds, Young v. Board of Commissioners of Johnston County, 190 N. C. 92, 128 S. E. 401, that under Laws 1921, c. 2, county commissioners may contract with the state highway commission for the loan of county funds to the highway commission for the construction of part of a highway system in the county, the purpose of the act being to encourage co-operation between the highway commission and the county authorities. The highway commission's agreement to repay is held to be a valuable consideration supporting the county commissioners' agreement to advance the money for the work.

AMOUNT OFFERED BY HIGHWAY COMMISSION FOR LAND NOT PROVABLE IN CONDEMNATION PROCEEDINGS

The Virginia Supreme Court of Appeals holds, Duncan v. State Highway Commissioners, 128 S. E. 546, that testimony showing the amount which had been offered by the state highway commission for land sought for highway purposes was not admissible in a subsequent proceeding for condemnation of the land, such an

CONTRACTS FOR ROAD CONSTRUCTION

The Oregon Supreme Court holds, De Neffe v. Duby, 239 Pac. 109, that where the statute requires a contract for public works to be let to the lowest responsible bidder a discretion on the part of the officials charged with the duty of letting such contract is involved, with which discretion the courts are not authorized to interfere although the contract is let to one who is not the lowest bidder.

A highway commission, it is held, in contracting for construction of a road, need not specify in advance the kind of pavement selected, but may call for alternative bids, provided the requirement of the Oregon statute that the commission adopt standard specifications is complied with. Under the Oregon statute construction of roads includes reconstruction and the commission has authority to reconstruct a road which has been paved. The statute authorizes the commission to improve the roads of the state, and the word "improvement" is not confined in its effect or meaning to dirt roads.